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RAILWAY SHOPS.

BY R. H. SOULE.

VIII.

THE PLANING MILL.

(Including the Cabinet Shop and Lumber Yard.)

The planing mill, cabinet shop, and lumber yard are so mutually interdependent that they must necessarily be considered together, and in nearly all plants they are under the same joint supervision. As they contribute their product to the construction and repair of both locomotives, passenger equipment cars, and freight equipment cars, and usually to the maintenance of building as well, both inside and outside of the motive power department, it is evident that their proportions can not be expressed on the unit basis; that is to say they cannot be definitely and completely stated, in so many square feet of floor space per locomotive stall or per car stall.

The only practicable method of approximating the dimensions, proportions, and relative arrangement to be adopted for these departments of a proposed plant, is to list up the principal existing general railway repair plants of the country, stating opposite each its estimated standing capacity for locomotives, passenger equipment cars, and freight equipment cars, together with the floor areas for planing mill, cabinet shop, and total. The analysis of such a tabulated statement will afford the only known basis for adopting proportions, but even then it must be determined what relation construction work and repair work are to bear to one another. Such a list will disclose the fact that planing mill proportions vary between very wide limits, and do not even approximate to fixed or standard ratios; also that the proportion of space allotted to planing mill and cabinet shops are hard to determine; this being largely due to the fact that cabinet shop work is partly machine labor and partly hand labor, and in many plants the machine work is done in the planing mill, and only the hand work done in a distinctive place of its own. Such a list will also disclose the fact that the combined planing mill and cabinet shop department of the new general shops of the Canadian Pacific, at Montreal, lead in point of size and capacity, their floor space, in square feet, being, planing mill 63,500, cabinet shop 17,980, total 81,480; there are two or three plants where the cabinet shop is slightly larger, but none which approach this in general floor area. The reasons for providing this exceptionally large planing mill plant are principally the facts that lumber and labor are both cheap in Canada, and the conditions are generally favorable for building both passenger equipment cars and freight equipment cars; besides which there are very few outside establishments in Canada which are able to handle such work on a large scale, and the great car building shops of the United States are too remote to be economically availed of. A close second to the Montreal plant is that of the New York, New Haven and Hartford, at Readville, Mass; here the floor areas, in square feet, are, planing mill, 43,750; cabinet shop, 20,000; total, 63,750. Readville is the nearest example of a large and modern railway planing mill plant.

When the layout plan of a proposed new shop has been completed, the first impression to anyone who has not individually worked on the problem is that the planing mill is very large relatively to the other buildings; but when that shop is considered in detail, the use of liberal proportions are easily justified. Both the bulk and the quantity of materials handled through a planing mill are very large as compared with those handled in any one of the iron working departments, the machine shop, for instance; and in the planing mill these conditions multiply upon themselves for the reason that in general, floor storage space must be provided both before and after each handling through a machine. It is for this reason that the ratio of floor area to the number of machine tools is much greater in planing mills than in machine shops, a well known fact. The easy and economical movement of lumber through the planing mill restricts such movement to the direction of the length of the pieces being handled, and this forbids the use of anything, but a building which is relatively long and narrow, which is the accepted type of planing mill building, subject to considerable variation in the exact proportion of length to width. Where buildings of a different type and shape are found, it is generally the case that the plant is small or of moderate size, and that the planing mill has been combined with a car shop for either passenger work, freight work, or both.

In a combination repair shop, locomotive cabs are usually repaired in the cabinet shop, and make a considerable demand on floor space; this fact is only one of several which constitute a strong argument for keeping the cabinet shop on the ground level, but nevertheless there are several cases where they are on a second floor, even where the layout suggests that they could easily have been located on the general ground level. It will, however, be found very burdensome and expensive to conduct a cabinet shop on the second floor; the bulk and weight of material to be handled both in and out of the shop is very considerable, and the finished product goes principally into passenger equipment cars, requiring that men from the cabinet shop must follow it and fit it in place; and in a large plant this must necessarily be done on the ground floor of another building separate and distinct from the planing mill. The preferred location for the cabinet shop is therefore on the ground floor and intermediate between the planing mill and passenger car shop, and actually under the same roof with one or the other; such is the arrangement at Readville, and it is ideal in that respect.

The amount of power required to drive a planing mill is also a surprise when the problem is first approached; although the cutting resistances of lumber are small relatively to those of iron, yet very high cutting speeds are practicable, and their products, the power used, is high. With the steam engine as prime mover its rotative speed, especially for high powers, being limited to low figures, the typical planing mill of previous days has been an object lesson which probably will find no parallel in the future; the necessarily great increase in rotative speed from the prime mover engine to the various tools, required the use of trains of pulleys alternately of maximum and minimum practicable sizes; the design of the various tools required that some should be driven from transverse shafts and some from longitudinal shafts; this brought into the combination the quarter twist belt with its mule pulleys, etc.; the strains on the belting and shafting being intermittent and in directions at right angles to one another, the roof had to be heavily trussed and braced to absorb the vibrations. The planing mill designed and built to-day may be free from all these troubles; the engine and boiler room annex is dispensed with and absorbed in the main power plant; there is no jack shaft, that is no single overhead shaft through which the entire power of the planing mill is transmitted, and which, in old time practice was the source and centre of the annoying vibrations before referred to. In the planing mill of to-day each tool or each group of tools may have its own motor, usually firmly placed on the floor; no quarter twist belt is required, and the application of power is so subdivided throughout the building that vibrations of the structure are not apparent. At Readville there are nine transverse shafts driven by five motors, all placed on the floor, and supplying the bulk of the power for the mill; the few remaining tools, which,

either from their design or from convenience of handling materials, are placed at right angles to the general run of tools, are driven by individual motors supported from the roof trusses. Large pulleys are noticeably absent, as the high motor speeds make their use unnecessary.

The course which materials follow in being passed through a planing mill is much more definite and uniform than in the case of the machine shop, for instance; it is consequently obvious that wood working tools should be located in a certain general sequence, such as cut off saws, rip saws, timber planers, planing and matching machines, tenoning machines, mortising machines, etc., with the other lighter and miscellaneous machines filling in the odd spaces.

As practically all wood-working tools are run at constant speeds, and as the planing mill is the one particular place where sparks are a dreaded source of danger, it becomes the ideal place for the use of the alternating current induction motor, which is both constant speed and sparkless. These considerations would seem to compel the exclusive use of the alternating current in planing mill work, and indicate that what may be called a combination power plant, that is a plant producing and distributing both direct current and alternating current, is ideal for a general railway repair plant. The rapid development and perfection of alternating current apparatus, and the increasing confidence in its use, make the combination practicable, and several such combination power plants are to be found in railway practice.

The disposition of shavings is somewhat more difficult than formerly; in the old steam driven plant the adjacent battery of boilers simplified the problem, and the movement of shavings whether by hand or by blast was a comparatively simple matter; under the present conditions of electric drive, the central power plant is often so far removed from the planing mill, that the problem of disposing of the shavings presents considerable engineering difficulties; this has led, in some instances, to placing a boiler locally at the planing mill, firing it with shavings and using the steam in the dry kiln throughout the year, and also for heating in the winter season.

Two necessary adjuncts to the planing mill are the dry lumber shed and the dressed lumber shed; these are often overlooked and neglected in the original layout, but being of essential importance, and vital parts of the plants, should properly be included and considered as part of the original problem; they are too often omitted from the original design and construction, and if subsequently provided at all, are apt to be of insufficient capacity under stress of restricted appropriations. Under the head of dry lumber is included all hardwood and expensive lumber whether kiln dried or not, and obviously its proper place is at the incoming end of the mill; the dressed lumber shed is particularly useful where many freight equipment cars are to be built new, as the conditions of economical production require that the planing will should keep ahead of the erecting shop, and therefore the dressed lumber shed should be between the two. Fine structures for dry lumber are found at both Montreal and Readville, but no separate shed for dressed lumber appears on the plans for either place; if the dry lumber sheds are used for the storage of dressed lumber as well, it must necessarily be accomplished by at least one retrograde movement.

The dry kiln is still more important, but is little understood, as exact information regarding its arrangement, proportions, and output, is very scarce, and such information as is on hand is widely scattered and seldom available. The Division of Forestry of the United States Department of Agriculture, at Washington, D. C., is collecting information on the subject and intends to issue a bulletin embodying facts and conclusions; this is very much needed and will be of very great service. It is known, however, that the forced circulation produced by the fan in the modern dry kiln has very greatly increased its output, as compared with the old method of natural draft. The dry kiln at Readville is the latest and most accessible example of good practice in this line. The New Haven road has nearly 2,000 passenger equipment cars, including, in this case, both sleeping cars and parlor cars, which is not usual; Readville being intended as the principal maintenance point for these cars, a capacious and efficient dry kiln plant was a necessity. Special all-steel long-wheel base standard gauge trucks are surmounted each by two smaller transverse trucks forming a cradle on which lumber is stacked; when the combination is run into one of the compartments of the dry kiln, the two cradle trucks with their load are run off on lateral tracks which are arranged at a proper level, and allowed to remain there until the drying process is completed; the main standard gauge truck, thus released, is available for handling other loads in or out. A system of external turntables completes the arrangement by which the several compartments of the dry kiln are brought into proper working relation with the lumber yard and planing mill tracks. In some modern dry kilns the moisture charged air which has been forced through and over the wet green lumber is subsequently passed between chilled pipes, by which means the moisture is precipitated and the air may thus be used over and over again, and kept warm with a moderate use of fuel, which is a measure of economy, especially in cold countries.

A study of lumber yard layouts leads to the conclusion that only a few have been carefully planned, while the majority are haphazard in their general features, and some are thoroughly inconvenient. It is believed that the most convenient plan is for the road tracks to be connected to a ladder at one end only, these main or road tracks to be spaced about 30 ft. centres, and to have a cross connecting track, with turntables, at the end of the yard opposite to the entrance ladder; the 30 ft. spacing makes it possible to stack 16-ft. boards crosswise to the tracks, and leave proper clearances at both ends, while long heavy stuff, such as sills, may be piled parallel to the tracks, practice having proven that these methods of handling these two classes of lumber are most convenient and economical; short oak and miscellaneous stuff may be stacked either way, in order to utilize remaining space to the best advantage. With a lumber yard so arranged every pile of stuff may be reached by a hand truck from either one of two adjacent tracks, the chances of both tracks being blocked being very remote. A very good alternative arrangement is to have only every other track connect with the ladder, the intermediate tracks being of lighter rail, and for the use of hand trucks only, road cars having no access to them. With this arrangement the cross tracks may be provided with turntables at every intersection with a longitudinal track or only at its crossings with the intermediate light rail tracks, either arrangement being practicable. One or two of the lumber yard tracks are run through the planing mill, and besides being used currently for trucking lumber in and out of the mill, will often be found convenient for handling car load lots of finished lumber for shipment to outlying points. At the West Burlington shop of the C. B. & Q. a depressed track enters the mill building at one end for use in this connection.

It will be found a very convenient working arrangement to locate the joint office of the planing mill foreman and the lumber yard foreman (and the lumber inspector, if there is one,) in the open space between the planing mill and the lumber yard, and in general, the dry kiln is within reach and observation from this point.

Up to the present time hand labor has been exclusively employed in lumber yard work, but with operations conducted on such a large scale as contemplated at Montreal and Readville, it seems entirely probable that labor saving appliances and machinery electrically driven, could be introduced to advantage. These two large plants are simply precedents in point of size, and may be frequently duplicated, or even exceeded in the future, and the mechanical talent on our railroads should not fail to grasp and meet the situation in this respect.

(To be continued.)

The Western Railway of France, has adopted electric heating for their special "corridor" trains, after an extended series of tests. Each car is to be equipped with ten electric heaters, of the foot-warmer type, which will be arranged in two circuits of five each.

STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

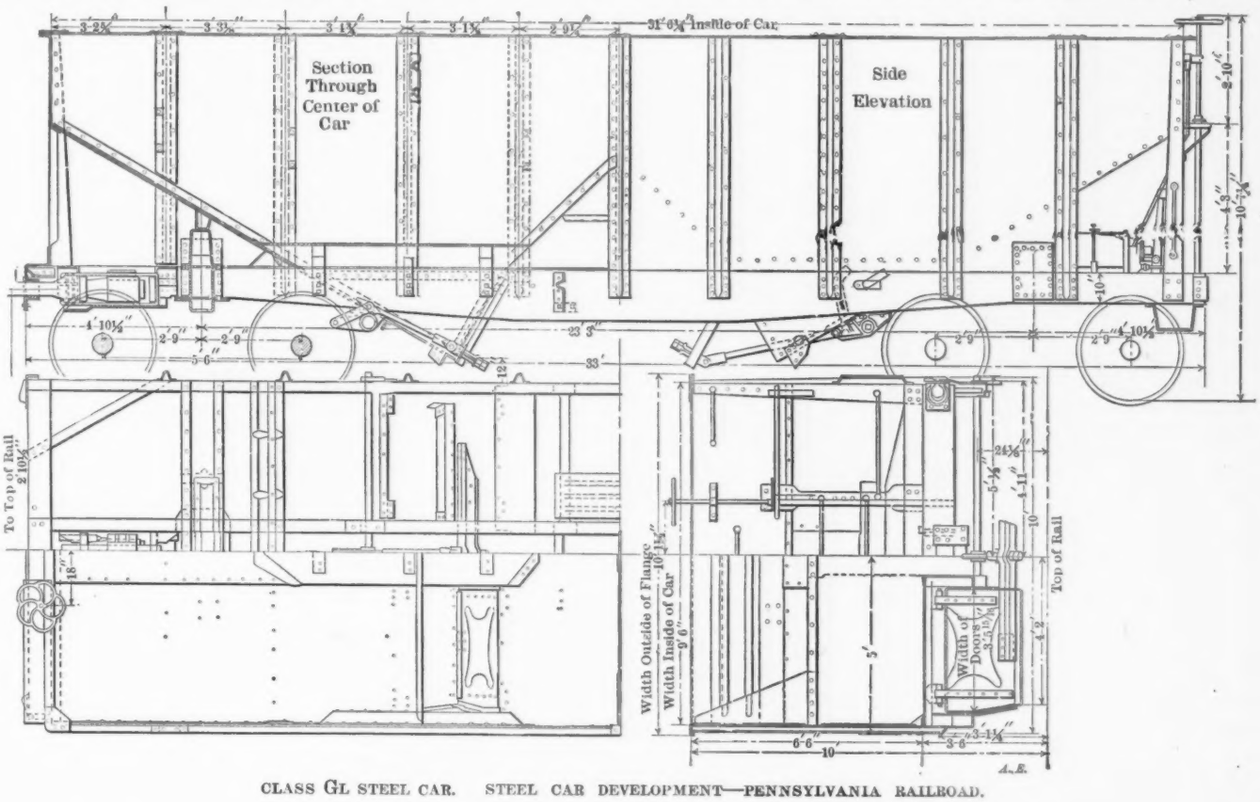
III.

(For previous article, see page 402.)

The first large all-steel, twin copper gondolas for the Pennsylvania Railroad were delivered by the Pressed Steel Car Company July 27, 1898. It seems but a short time since this important step in steel car development was taken. It was an important step because this GL car remains until now the standard coal car of this road. This type of construction was brought out in pressed steel on the Bessemer & Lake Erie, and its adoption by the Pennsylvania settled the form and type of the largest number of steel cars built in this country up to the present time. As already pointed out, the form was drawn from the class G6 wooden car. The design of the GL car was contemporaneous with the GM car, illustrated in this journal in November. It is almost exactly the same now as when first designed, but it will probably be redesigned in order to save weight, but without in any way impairing its strength. This car was built originally for the lines west of Pittsburgh and was used for coal in one direction and ore in the other. It was designed by the Schoen people and adopted by them, with modifications, for a large part of the equipment of this type built for other roads.

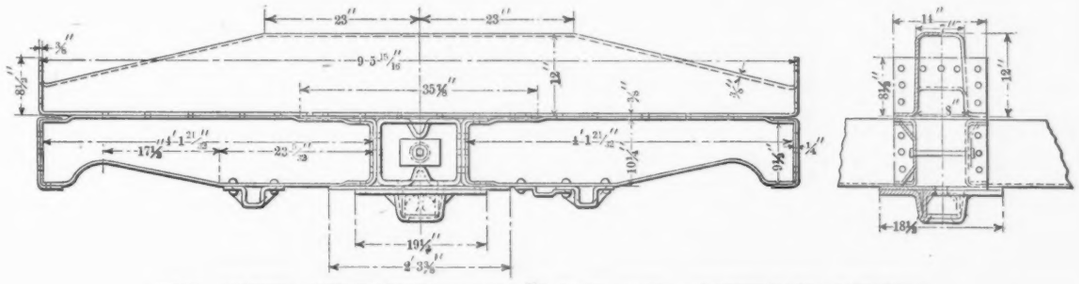
As shown on page 354, the weight of the GL car is 39,150 lbs. Its cubical capacity is 1,897 cubic ft., including the heap over the top, and the ratio of dead to paying load is 36.4 per cent. Its success is due to the fact that the facility of unloading coal and ore made it very popular with shippers.

The backbone of the GL car is a pair of fish-bellied pressed steel channels 17 in. deep at the center and 10 in. deep at the ends. They are continuous through the length of the car, 33 ft., and the bolsters are riveted to them. These sills receive the draft gear and are spread 12⅞ in. apart to receive the Westinghouse friction gear, which has been applied to all of the recent steel cars on this road. The side sills



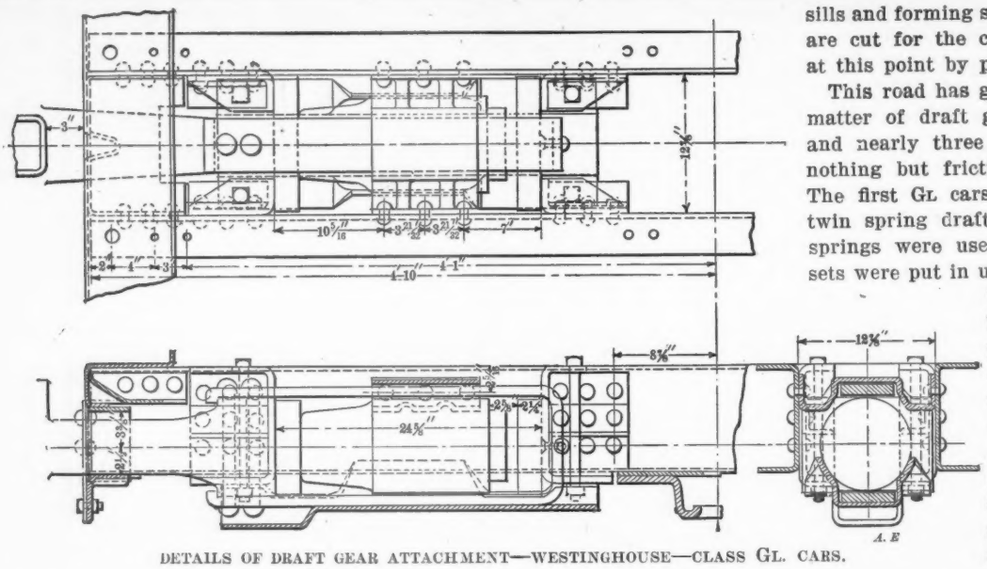
CLASS GL STEEL CAR. STEEL CAR DEVELOPMENT—PENNSYLVANIA RAILROAD.

of this car are also continuous and of the same form and size as the center sills, except that the side sills are of ¼ in. plate, while the center sills are ⅜ in. thick. In both cases the flanges of the channels are 3⅞ in. wide. This construction neglects the possibility of utilizing the sides of the car as trusses to aid in carrying the load and the heavy side sills might have been omitted, which would have saved a great deal of weight and considerable expense.



BODY BOLSTER CONSTRUCTION—CLASS GL STEEL CARS. PENNSYLVANIA RAILROAD.

With continuous center sills the lower portions of the body bolster were cut and made in the form of trough-shaped diaphragms, but the bolster proper lies on top of both center and side sills, and by its form is made to take some of the load from the sloping floor through a trough-shaped floor support, which bears on the bolster. This arrangement gives plenty of room for the bolsters, and it is easy to understand why these cars do not get "down on their side bearings." The



DETAILS OF DRAFT GEAR ATTACHMENT—WESTINGHOUSE—CLASS GL. CARS.

accompanying drawings are selected with a view of rendering an extended description unnecessary.

In all of the later forms of construction the center sills are continuous, and the bolsters are formed of trough-shaped diaphragms between them, with longer trough-shaped diaphragms between the center and side sills, riveted to their webs.

The end sills of the GL car are trough-shaped pressed plates Westinghouse friction gear had been long enough in service to determine whether it had reached its full development, and as a matter of fact, a number of changes were after- of ¼-in. material, fitting over the end of the longitudinal sills and forming strong end construction. They are cut for the coupler shank and reinforced at this point by pressed plate angles.

This road has gone very thoroughly into the matter of draft gear for large capacity cars, and nearly three years ago decided to apply nothing but friction gear to this equipment. The first GL cars were equipped with double twin spring draft gear in which two sets of springs were used in pulling and two other sets were put in under initial compression with but ⅜-in. of motion left. In buffing the follower pushed in pins which acted through the center of the springs, against the follower plate and loaded the second pair of springs. At the time this gear was designed it was not thought that the Westinghouse friction gear had been long enough in service to determine whether it had reached its full development, and as a matter of fact, a number of changes were afterward made in it. The spring gear gave fair service, but it was soon found that the Westinghouse gear was perfected so as to offer substantial advantages over springs alone, and the spring gear was abandoned in its favor. Since its first adoption this road has not used any but friction gear on large capacity cars. The Sessions standard friction gear is now applied to a number of cars on this road. The form of attachments for the Westinghouse draft gear on GL cars is illustrated in one of the accompanying engravings. In fact this arrangement is the one in use on all present types of steel cars on this road.

THE APPRENTICE QUESTION.

Mr. W. O. Thompson, division-superintendent of motive power of the New York Central at Oswego, N. Y., in a paper read last month before the Central Railroad Club, presented some of the features of the apprentice problem, in a way which should revolutionize practice in every railroad shop in the country.

In the opinion of the editors of this journal Mr. Thompson stated the case better than it has ever been stated before. The following paragraphs indicate its practical and sensible character. The author is certainly correct as to wages, unless the railroads establish schools for apprentice instruction:

"The average American boy, enters railroad shops at a salary that is not sufficient to take his girl to the circus and buy peanuts, all in the same evening, it does not take him long to see that the helper who does not know as much as the boy, after he has served three months, is getting enough to make him a comfortable living, and that if the helper shows himself a little proficient in some certain part of the business, he is paid a full-fledged mechanic's wages in a year or two. He also notices that it has been the policy of the railroads to better the condition of every one in financial and other ways from the president to and including the 'Dagos' on the section, with the exception of the apprentice. He also notices that he is looked upon with disfavor by a good many mechanics and barely tolerated by the sub-foremen; seldom noticed by the general foreman; and in a good many cases the division officer or superintendent of motive power is further away from him than the North Star. Under such circumstances is it any wonder that our boys get discouraged?

"What is needed is a complete change of heart and methods in regard to the apprentices. Instead of considering them as apprentices, we should look at it in the same light as we do in turning out more work every year for a given amount of money and the pace should be set by the highest division officer, and he should consider the welfare of his apprentices his paramount duty, and in that way create the opportunity of filling his shop with men fully prepared to successfully cope with their chosen profession.

"Apprentices' wages are altogether too low. Instead of compelling the boy to work one year for 5 or 6 cents an hour, he should work only six months for that pay. The next year his wages should not be less than $1 a day. The next year he should be paid nearly as much as the ordinary helper. The next year and the last six months of the fourth year he should be paid as much as the ordinary and special helpers' respectively. It is of the utmost importance that very careful consideration be given to the critical period of a boy's life, that is at the time of the completion of his apprenticeship. The practice of discharging an apprentice when his time is out is decidedly wrong. The proper time to get rid of undesirable apprentices is the first six months or a year at the latest.

"Satisfactory results cannot be obtained in any apprentice system without the proper interest being taken by the foremen to train an apprentice. The apprentice is the coming foreman, master mechanic and superintendent of motive power. The most vital part in the training of apprentices is the selection of mechanics as their instructors. It is not possible to obtain even medium results with boys without developing them outside of shops and to gain that which will be of lasting benefit to the boys and railroad companies as well, and an apprentice club or association should be formed where boys who have not been fortunate enough to get technical education can secure information on a variety of subjects that will put them on an equality which their more fortunate brothers. No apprentice system that can be devised will ever be a success unless every one, from the highest official to the mechanic entrusted with the education of the boy, appreciates the responsibility connected with starting an apprentice.

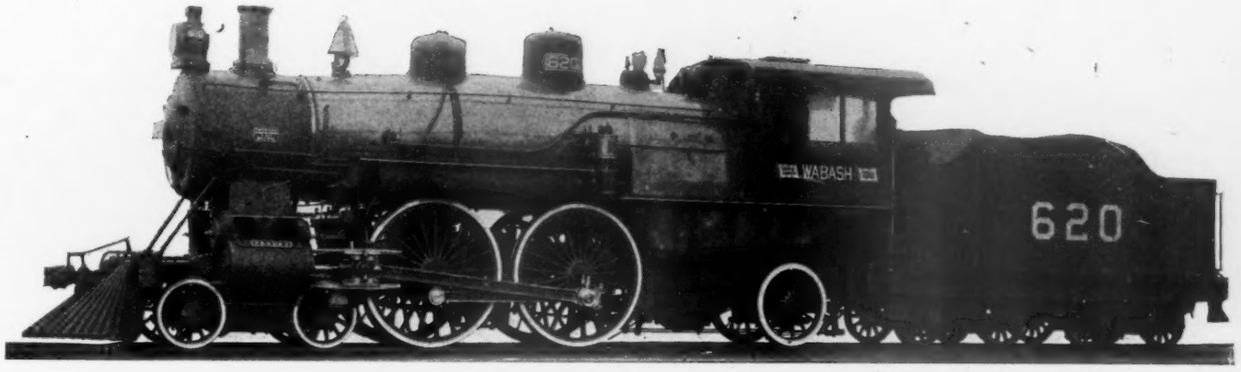
"We all point with pride to our special apprentice boys who have had the advantage of a technical training. We spend our company's money to re-educate them to the practical side of railroad life and as far as my observation goes with the same amount of money spent and the same pains taken in the way of giving the ordinary apprentice a chance for self-education suitable for shop apprentices, we will get better mechanics, more capable foremen and officers for higher positions than can be obtained in any other way."

NEW PASSENGER LOCOMOTIVE.

WABASH RAILROAD.

4—4—0 TYPE.

At the Brooks works of the American Locomotive Company some fine new passenger locomotives are being completed for the Wabash Railroad. They have steel frames, cast in a single piece, piston valves with inside admission and direct motion. The tractive effort is 23,500 lbs. In the drawings of the boiler the tendency toward providing wider water spaces for circulation is noticeable. The water space in front of the firebox is 5 in., at the sides and back the space is 4½ in. The tubes are 2 in. in diameter, with ¾ in. bridges. These engines have brake shoes on all wheels, including the trailers and truck wheels. For the trailers the usual provision for side motion is made. These locomotives are equipped with high-speed Westinghouse air brake, with retaining valves on the drivers.



PASSENGER LOCOMOTIVE—4-4-2 TYPE—WABASH RAILROAD.

J. B. BARNES, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE CO., BROOKS WORKS, *Builders.*

PASSENGER LOCOMOTIVE—WABASH RAILROAD.

Ratios.	
Heating surface to cylinder volume	= 257
Tractive weight to heating surface	= 36.2
Tractive weight to tractive effort	= 4.75
Tractive effort × diameter of drivers to heating surface	= 703
Heating surface to tractive effort	= 11.4%
Total weight to heating surface	= 68.

General Dimensions.	
Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	180,700 lbs.
Weight on drivers	96,700 lbs.
Weight engine and tender in working order	310,700 lbs.
Wheel base, driving	7 ft. 6 ins.
Wheel base, rigid	7 ft. 6 ins.
Wheel base, total	30 ft. 11½ ins.
Wheel base, total, engine and tender	56 ft.

Cylinders.	
Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	6½ ins.
Diameter of piston rod	3¾ ins.
Size of steam ports	1¾ ins. x 25½ ins.
Size of exhaust ports	65 sq. ins.

Valves.	
Kind of valves	Piston
Greatest travel of valves	5 9-16 ins.
Outside lap of valves	1¼ ins.
Inside lap of valves	0 ins.
Lead of valves in full gear	1-16 in.

Wheels Etc.	
Number of driving wheels	4
Diameter of driving wheels outside of tire	83 ins.
Material of driving wheel centers	Cast steel
Thickness of tire	3½ ins.
Tire held by	Shrinkage and retaining rings
Driving box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 12 ins.
Diameter and length of main crankpin journals:	6½ ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals:	7¼ ins. diameter x 4¼ ins.
Engine truck, kind	Swing
Engine truck journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	36 ins.
Kind of engine truck wheels	McKee-Fuller spoke

Boiler.	
Style	Radial stayed extended wagon top
Outside diameter of first ring	64¼ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox:	11-16, ¾, 9-16, ½, ½ in.
Firebox, length	102 ins.
Firebox, width	63 ins.
Firebox, depth	Front, 75½ ins.; back, 65½ ins.
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 5 ins.; sides, 4½ in.; back, 4½ ins.
Tubes, material and gauge	Iron; 11 B. W. G.
Tubes, number	294
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft. 4 ins.
Heating surface, tubes	2,499 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	2,676 sq. ft.
Grate surface	43.7 sq. ft.
Grate, style	Rocking
Exhaust nozzles	5⅛ ins. diameter
Smoke stack, inside diameter	14½ and 16¾ ins.
Smoke stack, top above rail	15 ft. 3 ins.
Boiler suplied by	Two No. 10 Ohio injectors

Tender.	
Style	Eight-wheeled
Weight, empty	55,460 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	17 ft.
Water capacity	6,000 U. S. gals.
Coal capacity	12 tons

WHY DO STAYBOLTS BREAK?

The following is taken from a paper read at the Foreman Boiler Makers' Convention at Chicago by Mr. John Livingstone:

Your chairman produced a board to show 171 heads of staybolts from the right side of the fire box on the fireside sheet of a locomotive; at least 75 out of the 171 were burned. You have held that the breakage of staybolts is due to expansion and contraction, and unable to counteract the expansion and contraction with the solid staybolt, discussion centered on flexible staybolts.

Too little heed was paid to the lesson taught on the board, too little consideration was given to the prima facie fact, that 44 per cent. of the heads of those staybolts were burned. When the bolts commence to burn at the inside of the sheet, the burning continues inward until protected by the water. The heat that causes the burning causes expansion at its inner end, and in the hole of the sheet; and that expansion is met by resisting expansion in the sheet (solid against solid) with risk that both the sheet and the bolt will crystallize. The sheet, which may also burn, may crack between the bolts; the bolts will break, not always where the force of rigid compression obtains; sometimes where by the concentration of force there, the other part of the bolt snaps under the varying vibrations and strains it has to endure. The sheet in ordinary service cannot be burned so long as there is water behind it, for iron has capacity to convey to the water the heat it obtains from the fire, however fierce; but if burning is commenced at the inner end of the staybolt it will extend outward and imperil the sheet immediately around it.

Though riveted close to the plate the inner end of the bolt is only mechanically in touch with the plate, and cannot exercise the functions of the sheet in giving to the water the heat by which it is attacked. The water protects the sheet from burning and the heat passes through the iron to the water.

To avert the risk of burning from the inner end of the bolt outward, there is only one way and that is with air through the center of the bolt and the water around it; nor can you unduly expand a bolt of that character. It will receive the force of the expanding sheet without the resistance of its own power of expansion to the extent occurring in a solid bolt.

RAILROAD SHOP MANAGEMENT.

By William S. Cozad, Norfolk & Western Railway.

I.

Long experience in locomotive and car shop work has proven very conclusively, I think, to the average shop manager that any system of shop supervision that is not founded on the principle of co-operation or of renumerating the employee according to the amount of service performed, whether of brain or muscle, affords neither substantial justice to the workman, for sufficient returns to the owner for capital invested.

In a railway repair shop where almost every conceivable class of work is performed from tapping a nut to building a locomotive complete, it is generally conceded, in the light of all the knowledge we have on the subject at present at least, that straight piece-work or a fixed price for each operation, when properly applied, is best adapted to such a great variety of work. The object of this article, therefore, will be to discuss in a general way, the subject of shop organization and the relation which must exist between the management and the men before any decided steps can be taken towards putting the shop on a satisfactory piece-work basis.

In entering into this work it is necessary to understand that the introduction of piece-work in any department changes, not only every condition, but the entire atmosphere of the shop, and one of the first things to be remembered by the foreman is that he is dealing with a body of intelligent men, who, like himself, are always on the lookout for their own best interests and any dishonest methods or dark lantern processes will be destined to end in failure.

The foreman and his immediate subordinates, who are held responsible for results, must recognize the fact, especially if it be a large plant on which the eye of the management is continually centered, that the average general manager or superintendent of motive power is not a piece-work expert, and if he were, he has no time to look into details, and must necessarily hold his subordinate officers, such as general foremen, foremen of departments and gang foremen, responsible for the successful operation of the shop.

The master mechanic or general foreman who has kept pace with the times will not need to be told that, until very recently, in the discussion of this subject by the higher railroad officials at their association meetings about two out of every three were opposed to piece-work in any form in a repair shop, and many motive power officers are not yet willing to admit that this system of paying for work can be made successful in certain departments. So that, after all, the introduction of piece-work is a matter of education.

The foreman, then, must feel that if piece-work is introduced into his shop at all, it will be due almost entirely to his efforts; and whatever of success it is attended with, is properly to be credited to himself and the men in his charge.

In almost every day-work shop ninety out of every hundred men are opposed to piece-work. And why? Because they fear it will eventually result in a general reduction of their wages; that it will finally reduce the number of men employed in the shop and will at last either dispense with the services of the old men, or require them to work much harder at a reduced compensation.

This last named objection should be given careful consideration. The railroads of the country owe a debt of gratitude to their old employees. They should be taken care of and should not be required to work piece-work, except at their own request.

Mr. Carnegie, in his "Gospel of Wealth," argues that age is not a condition made by human institutions, and the right to weed out old men is decreed by natural law, which law, says he, "may be sometimes hard for the individual, but is best for the race, because it insures the survival of the fittest in every department." The privilege to carry out this idea may be necessary in the management of a private concern but any attempt to introduce piece-work with this end in view ought to be doomed to failure.

Some men never grow old, except in years, and in my experience I have frequently come in contact with employees who were on the downward march in life, who could take the piece-work prices of the average mechanic and very materially increase their day rate, and were glad of the opportunity to do so.

In another article on this subject, I shall attempt to show that it is not the unusual effort of the workman that brings about, both increase in the out-put of the shop and in the wages of the man, but the introduction of improved tools and a systematic method of handling the work.

But going back to the subject in hand, a very large part of all that has been read and heard by the man in the shop on the subject of piece-work in the past, has been to effect that it is detrimental to the best interests of the average mechanic; and it is a fact which we have to admit, that in many instances in the past, piece-work has been the means in the hands of unscrupulous and dishonest foremen to take advantage of honest workingmen in depriving them of a just reward for honest toil. Entire confidence, of the men, then, is the first thing necessary, and the intelligent foreman, or general foreman, or master mechanic, or superintendent of motive power, for that matter, if he would finally succeed in this work, will not be in any big hurry about putting a great number of prices into effect, but will go to work diligently to first win the confidence and good will of the men and bring about a general good feeling in the shop. And while this process is going on it is very essential that the foreman and those in charge of the various departments of the shop look about them and see if there are not a great many things that need to be given attention in order to insure better results, even on a day work basis. A careful inspection of the shop may disclose the fact that there is a great deal of material scattered about that ought to be in the scrap pile, or at least does not belong inside the shop. No good ever came from a dirty shop. Dirty, greasy machines; old castings, forgings, useless bolts, scrap and many other things that might be mentioned, if left lying about the shop, are demoralizing to the workmen and create an atmosphere of indifference, slovenly ways and expensive methods of doing the work.

One of the leading superintendents of motive power in this country once said to me while I was in his service, "Show me the conditions under which men work in any shop and I will tell you not only the quality of the work, but the cost as well." Therefore one of the first moves to make in preparing for the successful introduction of piece-work is to "clean up," and then "keep cleaned up." You must figure that when men are on a piece-work basis they have no time to climb over piles of useless material. They cannot work on engines to the best advantage with all kinds of unnecessary material in the way. Blocking lying about the floor. Old lagging, truck wheels, dome casings, driving wheels, scrap and all work as fast as taken down, where there is not a special department set aside for this work, must be kept cleaned away to allow the men to work to best advantage.

Cultivate among the men by precept and example a spirit of activity and energy. And the workman who wishes to forge to the front will show to his superiors that he delights in his work; that he is never so happy and contented as when busily engaged in the work of the shop.

"The first external indication of the dry-rot in men," says Dickens, "is a tendency to lurk and lounge; to do nothing tangible to-day, but to have an intention of performing a number of tangible things to-morrow or the day after."

The successful management of a large body of men, or any number of men for that matter, no doubt, depends largely on the personality of the foreman, but after all, the foundation of governing and being governed was laid centuries ago in that old rules of rules, "Do unto others as you would have others do to you." Justice must be the spirit that actuates and controls our movements. A broad appli-

tion of the spirit of right between man and man is the only thing that will pay 10 per cent. on the investment.

Men must understand that they are appreciated; that the success or failure of the institution is with them; that if success attends the operations of the shop, the credit will belong largely to the men in the ranks. "Too much still remains of the old idea that work is a curse, a punishment, instead of being the only real pleasure in life."

Every man has a right to make each day stand for something. In all the nooks and corners of human existence there is no place for an idler, or dreamer. It is better to carry a hod or wield a shovel in an honest endeavor to be of some use to the community than to be nursed in wealth and live off the toil of others. The man who sets himself earnestly at work, no matter what the sort of labor, dispels at once all the elements of discontent, doubt and envy and applies a sure remedy for that disease commonly known as the "blues." He takes a new lease of life, and the successful shop manager must educate his men to be energetic, industrious, active, always on the alert looking for some means of bettering the service.

Sir Walter Scott, writing to his son at school, said, "I cannot too much impress upon your mind that labor is the condition which God has imposed upon us in every station of life; there is nothing worth having that can be had without it." It is still water only that becomes stagnant and is finally covered with the green scum of inactivity. The running brook at all times sparkles with the living fire of usefulness.

To the master mechanic or general forman who contemplates the introduction of piece-work at some future date, let me suggest that if you have not already done so, there is no move which you can make which will so materially assist the sub-foreman in carrying out the above suggestions and so quickly instill new life into the entire shop, as the organization of a Shop Foremens' Association, to meet at stated periods, say once each month, to discuss means and methods of bettering conditions and increasing the out-put of the shop. It may be that changes will necessarily have to be made before you are in a position to consider piece-work at all, and there can be no better way of finding out just what the conditions are than by calling together and consulting those in immediate charge of the work.

(To be continued.)

HEAVY FREIGHT LOCOMOTIVE.

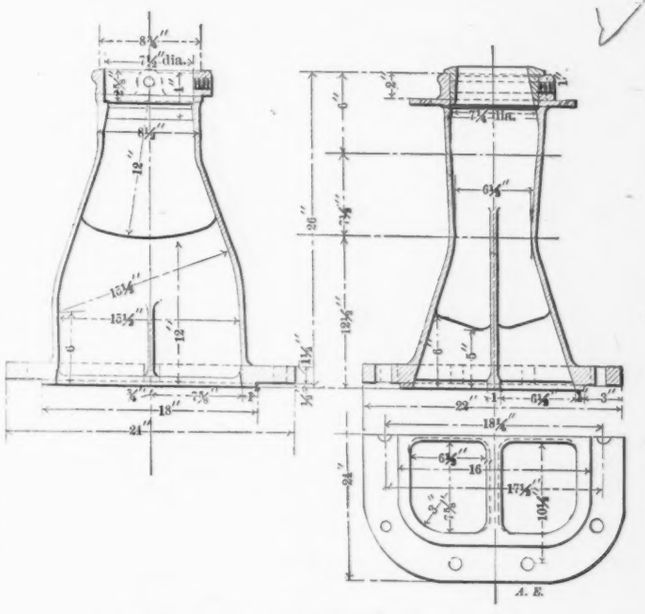
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

2—8—0 TYPE.

SOME OF THE DETAILS OF CONSTRUCTION.

The previous article on this subject appeared on page 415 of the November number of this journal, and the description will require another article in addition to the present one. The design represents special efforts on the part of the mechanical officers of the road and of the American Locomotive Company to produce an engine which will materially reduce the number of "engine failures" in service.

The boiler of this engine was passed over rather too easily in the description last month. This is a very large boiler. Its diameter at the smoke box is 80 in., and at the largest diameter it is 87½ in., which is unusual. This large size was used at the throat connection, in order to facilitate the circulation by providing plenty of room for the water to pass back to the water legs. It is a pleasure to see these efforts in the direction of improvement in circulation of locomotive boilers. At best there is little enough room for water to get back to the side sheets. The tube spacing is wide, with a "bridge" of 15-16 in. between flues. The drop grates are



DETAILS OF THE FOUR-CHAMBER EXHAUST PIPE.

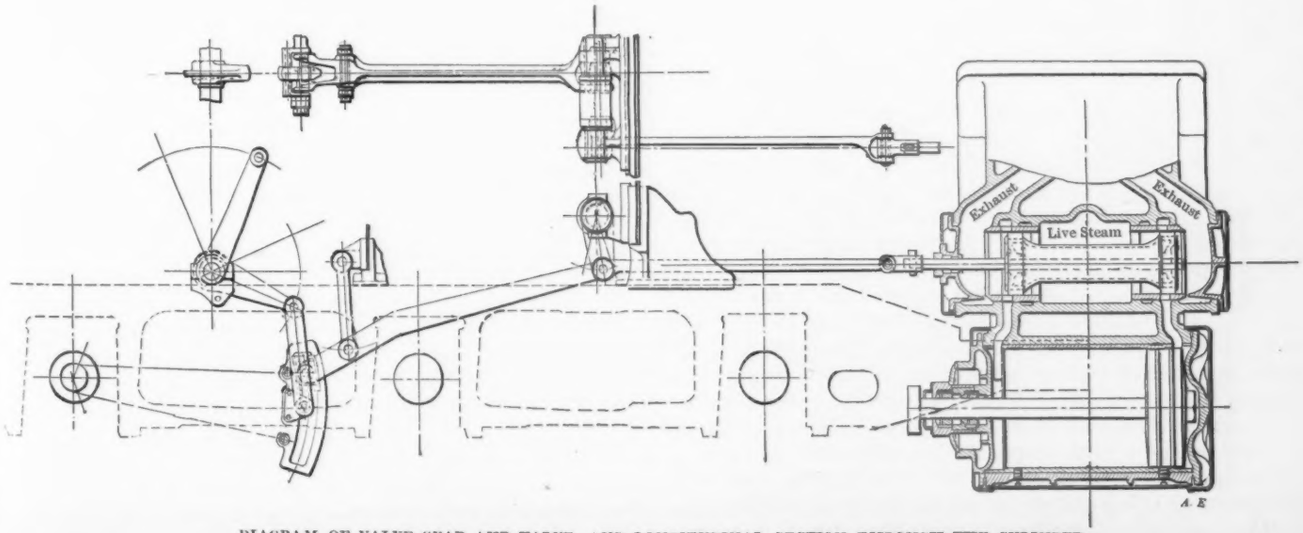


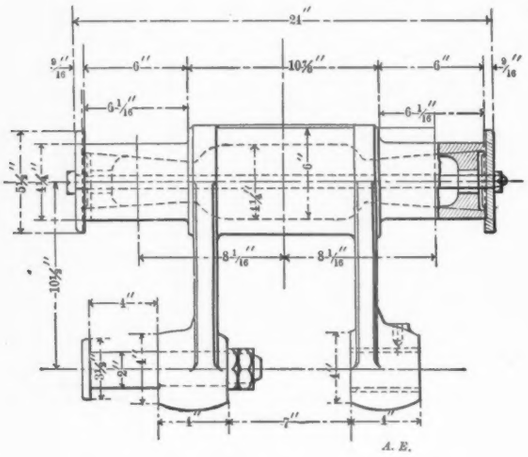
DIAGRAM OF VALVE GEAR AND VALVE, AND LONGITUDINAL SECTION THROUGH THE CYLINDER.

CONSOLIDATION (2-8-0) FREIGHT LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

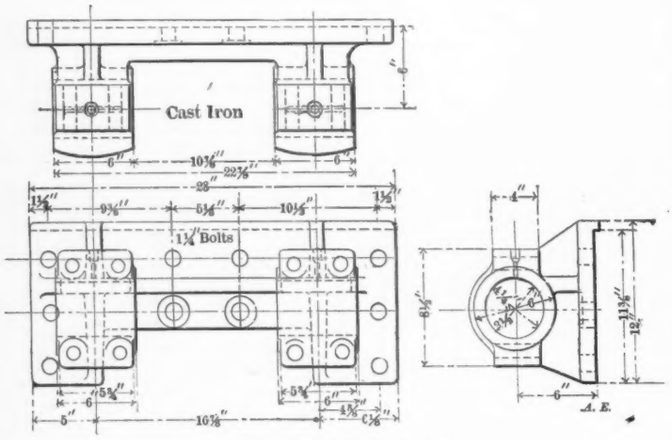
H. F. BALL, *Superintendent Motive Power.* American Locomotive Co., Brooks Works, *Builders.*

made as low as possible in order to secure space between the tubes and the level of the fire.

This locomotive has inside steam admission with very carefully arranged steam and exhaust passages, by using the Player four-chamber exhaust pipe the exhaust blasts are kept separate to a point 5 in. above the base of the exhaust nozzle, but this is not all. The exhaust steam passages are kept away from those containing live steam through the saddle, in order to prevent the exhaust from drawing heat away from the entering steam and causing initial cylinder condensation. A glance at the longitudinal section through the cylinder, shown in connection with the valve gear, shows



THE HOLLOW TWO-BEARING ROCKER SHAFT.



DETAILS OF ROCKER BOX.

2-8-0 FREIGHT LOCOMOTIVE.—L. S. & M. S.

these passages clearly. This is an important matter which does not always receive the attention it deserves.

By aid of the drawing of the assembled parts of the valve gear, including the valve, the idea of the "central-direct" valve motion is illustrated. This construction is admirable. It places the pin as far as possible, in double shear, and by using a heavy and strong rocker casting the spring of this motion should be reduced to the lowest terms. The hangers are double. Obvious advantages are obtained by this construction. It will be noted that the English form of link is used and that the transmission bar is coupled to an inverted rocker, the rocker box being secured to the guide yoke and the rocker shaft has external bearings. This reduces the rocker box to a very simple casting, with two 4¼ by 6 in. bearings, with a space of 10⅞ in. between them. In order to reduce the liability of the rocker to twist, the two bearings were used and the rocker, made of cast steel, was given the form shown in the detail engraving, with the journaled portion made hollow. It is difficult to see how this rocker can twist or spring. Furthermore, the bearings are large and very easily taken down.

The valves are of the usual piston type as constructed at the Brooks Works, their general features having been illustrated in this journal.

Among the other details, which are specially worthy of close attention, are the frames and their bracing, the leading trucks and the ash pan. These will be reserved for another article, as it is specially desirable to place the frame construction on record in a thorough manner. These frames are the first coming to the attention of the writer in which an effort is made to provide for latent stresses. This work seems likely to prove to be exceedingly important.

OPERATIONS OF "PER DIEM" RULES FOR CAR HIRE.

Perhaps the most frequent objection made to the operation of per diem rules has been that the rules have not accomplished what the advocates of the per diem principles claimed they would; namely, the return of cars to owners, but, in the opinion of well-informed men, there is no per diem rate which can be established high enough to accomplish this purpose in all cases. When cars are not returned to owners, it is usually because there is a very active demand for them, or because the borrowing line is so seriously congested that it is physically impossible to make prompt return of cars. In either case, whether the rate be 20 cents a day or $1 a day, the return of the cars will not be forced.

Already, however, the rule has had very important results in compelling lines whose equipment was manifestly inadequate, to increase their equipment and compel lines that suffer not infrequently from serious congestion of traffic, to increase their facilities so that this congestion would not occur. Beyond question, per diem has stimulated representatives of railroads to the importance of moving cars promptly, and the justice of the position appeals to all men. In the past the railroads have not unfrequently been the worst offenders in the matter of detaining each others' cars. Not that I claim this was done intentionally, but that it was done because there was nothing to call attention to the importance of prompt movement. Now, however, railroads are treating themselves on what may be termed a "car service basis," and are in a better position to justify the charge for detention of cars by shippers and receivers of freight.

The strongest argument of the opposition to the per diem system was that the per diem rate would greatly increase empty mileage. In this they have certainly been mistaken, for this has not been noticed. The real difficulties in the operations of the rules, while not unimportant, require, as it seems to me, only a better understanding of these difficulties and the principles underlying the question to find a ready solution. From a paper by Mr. F. A. Delano, read before the Iowa Railway Club.

The floors of the new shops of the American Locomotive Company, at Schenectady, were very carefully laid and are quite satisfactory. The basis was a filling of sand over which from 4 to 6 ins. of small broken stone was laid. This was flushed with a gallon of hot coal tar for each square yard of surface. A course of 2 ins. of hot sand and tar mixed thoroughly to the consistency of mortar followed this and was rammed to a level surface. In this 3 by 4 ins. railing strips were imbedded at 3 ft. centers. Rough hemlock planks, 2 ins. thick, were spiked to these, and the top flooring of ⅞ ins. tongued and grooved maple was finally laid. It is an expensive but very satisfactory and permanent floor.

Col. James H. Bailey, who for the past 20 years, has been an owner and very influential in the *Railroad Gazette*, has severed his connection with that journal and retires from all active work. He had a very large and extensive acquaintance among the railway manufacturers of the country and will be very much missed, particularly at the railroad conventions.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

V.

VERTICAL DRILL PRESSES.

The ordinary vertical drill press in a locomotive repair shop has to handle drills, reamers, etc., varying from ¼ inch to 2½ inches in diameter; and the material to be drilled will vary from soft brass to the hardest cast iron or steel. Such a drill press, belt driven, usually has a back gear and a four-step speed cone, thus giving eight different spindle speeds for the entire speed range.

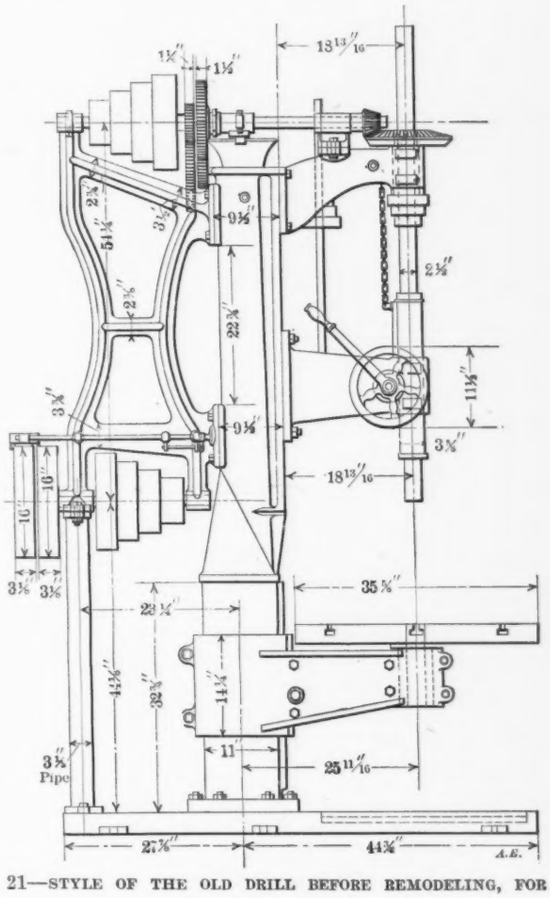


FIG. 21—STYLE OF THE OLD DRILL BEFORE REMODELING, FOR AN INDIVIDUAL DRIVE.

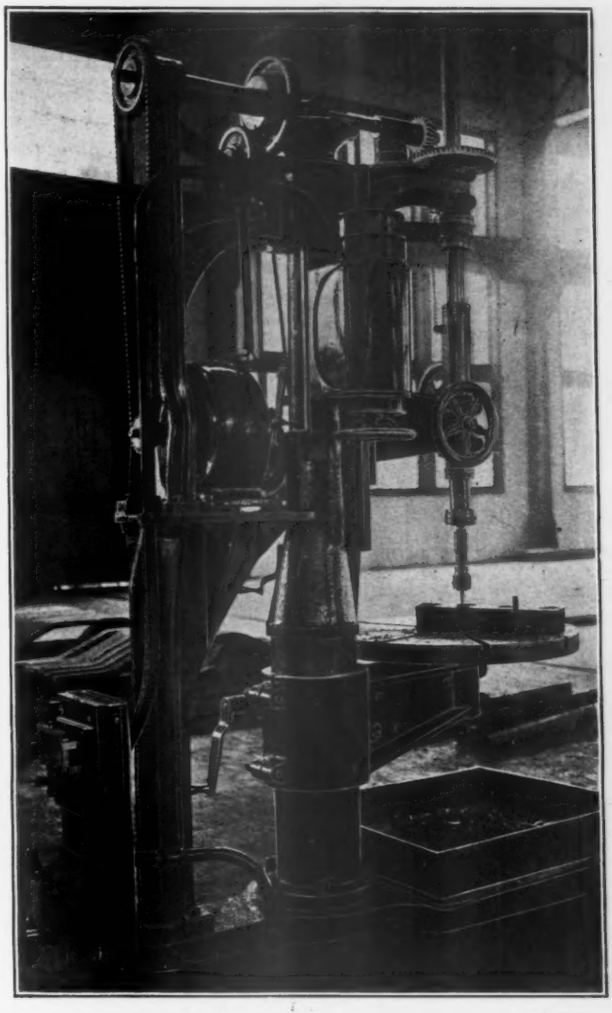


FIG. 22—APPEARANCE OF THE DRILL AFTER BEING EQUIPPED WITH THE CROCKER-WHEELER MULTIPLE-VOLTAGE DRIVE.

INDIVIDUAL DRIVING APPLIED TO OLD TOOLS.—PITTSBURGH & LAKE ERIE RAILROAD.

The following data are taken from the very complete table, found on page 957 of Kent's Mechanical Engineer's Pocket Book, giving the speeds for various diameters of twist drills as recommended by the Morse Twist Drill & Machine Co., and are presented to indicate the entire inadequacy of the ordinary drill press to meet the requirements for rapid drilling.

TABLE OF SPEEDS REQUIRED FOR TWIST DRILLS.

Diam. of Drills.	Speed, Rev. per Min.		
	For Steel.	For Iron.	For Brass.
¼-in.	230	320	400
½-in.	115	160	200
¾-in.	75	105	130
1-in.	58	80	100
1¼-in.	46	62	80
1½-in.	39	54	66
1¾-in.	33	45	56
2-in.	29	39	49

The table from which this data is taken, gives the speeds required for all sizes, varying by sixteenths of an inch in diameter, but those above only are shown, for each ¼ inch in diameter, in order to present some idea of the wide range of speed which should be provided. By thus bringing out the great differences in speed required by drills of different diameters, it is clearly shown that the eight spindle speeds usually provided, are entirely inadequate if the best results are to be obtained. This point is emphasized even more when we consider that in place of three different materials, only, which are provided for in the above table, several more should be added when the different grades of iron and steel are taken into consideration, i. e., cast steel, machine steel, mild steel, cast iron, wrought iron, etc.

Unquestionably the application of a variable-speed motor to the drive of such a tool will prove a paying investment, since in place of the eight spindle speeds, when belt driven, we will have with the use of the variable-speed motor and a back gear, three or four times as many.

In Figure 21 is shown the type of the belt-driven vertical drill press, with 36-inch table, of which there were five in the old shops of the Pittsburgh & Lake Erie, at McKees Rocks. All were in good condition or such that a few repairs would make them so, so that it was decided to equip them with individual drives. The bracket which was used to carry the speed cones was so designed that it could not be used to support the motor, and it was replaced by a combination set of bracing and motor support brackets.

Figures 22 and 23 show the drill press as equipped with the new brackets and the variable-speed motor. The motor brackets were made quite heavy in order to add stiffness and strengthen the machine against vibration. The cone on the

upper horizontal shaft was replaced by a sleeve, to the outer end of which is keyed the Morse Silent Chain sprocket, and to the other end of which is keyed a new gear, as indicated in Fig. 23, to replace the old one on the end of the cone. Also the old lock plate which is used for changing from back to single gear was added. In order to get the proper speed ratio, between the single gear and the back gear only two gears had to be changed as is shown in Fig. 23.

The motor is located high enough to be out of the way of dirt and metal cuttings, and yet is low enough to be easily accessible. It is also low enough to prevent the tool from being top-heavy with resultant excessive vibration. While running at the highest speeds, in single gear, the tool vibrates only slightly. The controller is placed in a convenient position so that the handle is within easy reaching distance of the operator, as shown in Fig. 23.

The question of the amount of power necessary to be provided at the motor, was a serious one. The difficulties which were at first met in adapting the high-speed tool-steels

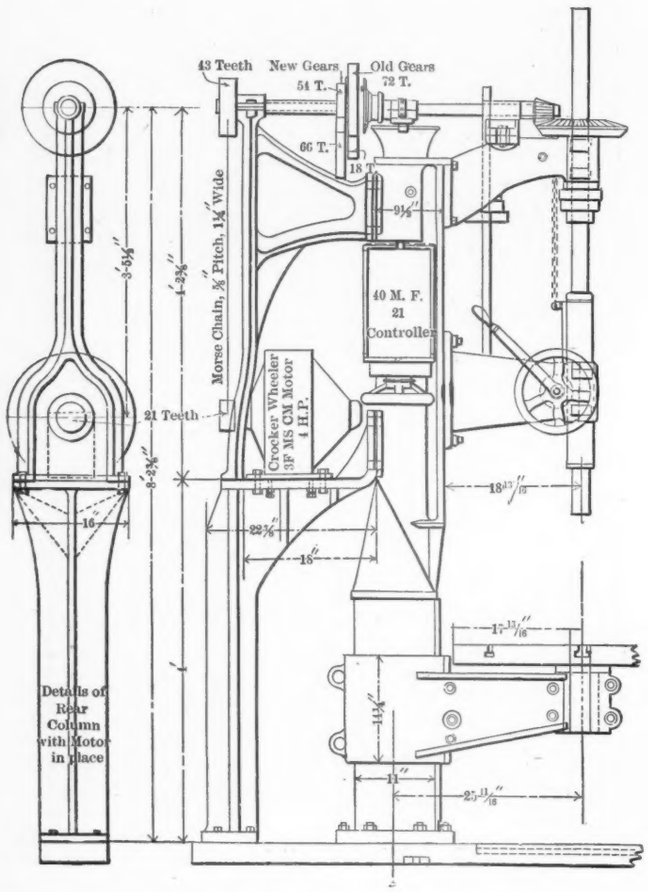


FIG. 23.—DETAILS OF THE TOOL AS EQUIPPED WITH THE NEW BACK BRACING AND THE ELECTRIC DRIVE.

to twist drills, are apparently being overcome, but as yet there seems to be no reliable information as to just what can be done with them. To provide for the possibilities of progress in this direction enough power was provided for to take care of the ordinary twist drill steel with a fair margin of reserve if a better steel should appear for such purposes.

The variation of power at the motor with the multiple voltage system of driving is indicated in the diagram, Fig. 25, which shows the motor horse-power available at the various drilling speeds that are provided at the spindle. This curve was plotted with the aid of the power diagram, presented in Fig. 1, (page 165, May, 1903 issue), which shows the relation between the speed and the power of a motor used with the M.-F. 21 controller, on the Crocker-Wheeler multiple-voltage system.

Since these drill presses have been equipped with motors, a rough series of tests have been made with drills up to 2 ins. in diameter, with the result that it was shown that ample power has been provided to take care of the ordinary grade of twist drill steel; also that a considerably better grade of steel, which would allow of the use of higher speeds, can be made use of without overloading the motor, except between speeds from 73 to 106 revolutions per minute.

The Crocker-Wheeler motors which are being used are, however, so designed that, if necessary, a considerable overload can be carried without injury. In the event of a higher speed

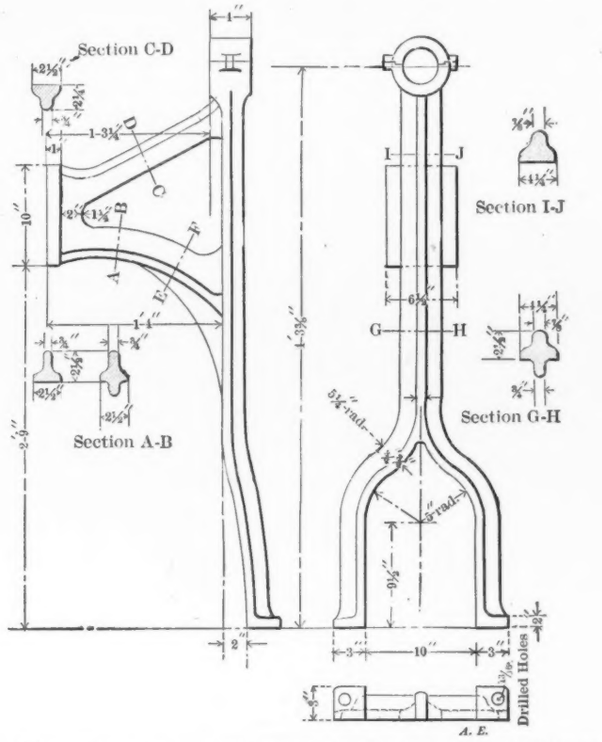


FIG. 24—DETAILS OF THE COMBINED BACK BRACE AND HORIZONTAL SHAFT SUPPORT.

steel being produced, which can be adapted to twist drills, and whose use with certain diameters of drills will cause the overload between the above mentioned speeds to be excessive, provision can be made for the use of such steel, by increasing the back gear ratio by replacing the two new gears, noted on

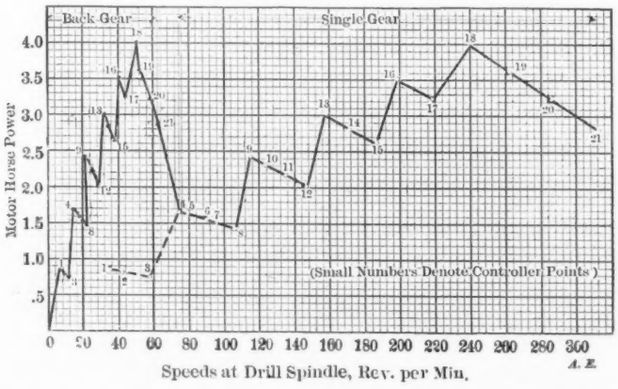


FIG. 25—DIAGRAM INDICATING VARIATION OF POWER AVAILABLE AT VARIOUS SPEEDS WITH THE MULTIPLE VOLTAGE SYSTEM OF DRIVING.

Fig. 22, with two others, so that the spindle speeds in back gear will still further overlap those in single gear.

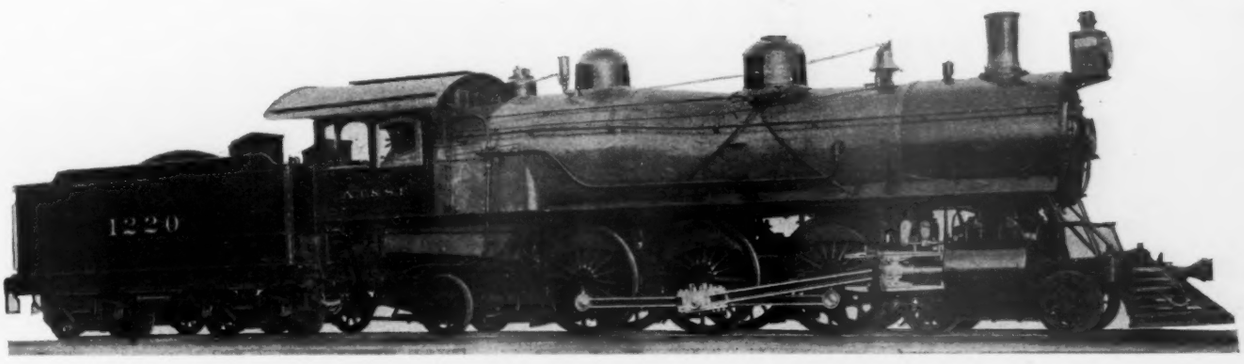
In providing power for drill presses, the largest diameter of drill which is to be used will govern the amount of power to be provided, since it has been found that the power required varies as the diameter of the drills, although not in the same ratio.

POWERFUL PASSENGER LOCOMOTIVE.

4-6-2 (PACIFIC) TYPE.

ATCHISON, TOPEKA & SANTA FE RAILROAD.

The Baldwin Locomotive Works have completed new locomotives of the 4-6-2, or Pacific type, for passenger service on the Atchison, Topeka & Santa Fe Railway. These are very heavy and powerful. They are simple engines with 22½ by 28 in. cylinders, 69 in. driving wheels, and carry 220 lbs. steam pressure. While being really as heavy as the very large passenger locomotives of the same type now running on the Chicago & Alton, illustrated on page 87 of our March issue, the heating surface is much less and the water spaces in the boiler larger. These are very powerful engines. Their chief dimension are as follows:



POWERFUL NEW PASSENGER LOCOMOTIVE.—ATCHISON, TOPEKA & SANTE FE RAILWAY.
4 6-2 TYPE. BUILT BY BALDWIN LOCOMOTIVE WORKS.

Ratios.	
Heating surface to volumes of cylinders	= 279.2
Tractive weight to heating surface	= 39.1
Tractive weight to tractive effort	= 3.66
Tractive effort × diameter of drivers, to heating surface	= 738.
Heating surface to tractive effort, per cent	= 9.35
Total weight to heating surface	= 59.85
General.	
Gauge	4 ft. 8½ ins.
Cylinder	22½ x 28 ins.
Valve	Balanced piston
Boiler.	
Type	Wagon top
Material	Steel
Diameter	70 ins.
Thickness of sheets	21-32 in., ¾ in. and 25-32 in.
Working pressure	220 lbs.
Fuel	Coal
Staying	Radial
Firebox.	
Material	Steel
Length	108 ins.
Width	71¼ ins.
Depth	Front, 78⅝ ins.; back, 68⅛ ins.
Thickness of sheets:	
Sides, ⅝ in.; back, ⅝ in.; crown, ⅝ in.; tube, ½ in.	
Water space	Front, 4½ ins.; sides, 5 ins.; back, 4 ins.
Tubes.	
Material	Iron
Wire gauge	No. 11
Number	290
Diameter	2¼ ins.
Length	20 ft.
Heating Surface.	
Firebox	122.8 sq. ft.
Tubes	3,402 sq. ft.
Total	3,595 sq. ft.
Grate area	53.5 sq. ft.
Driving Wheels.	
Diameter of outside	69 ins.
Diameter of inside	62 ins.
Journals	Main, 10 x 12 ins.; others, 9 x 12 ins.
Engine Truck Wheels.	
Front—Diameter	34¼ ins.
Journals	5½ x 10 ins.
Back—Diameter	40 ins.
Journals	7½ x 12 ins.
Wheel Base.	
Driving	13 ft. 8 ins.
Rigid	13 ft. 8 ins.
Total engine	33 ft. 9½ ins.
Total engine and tender	62 ft. 10½ ins.
Weight.	
On driving wheels	140,800 lbs.
On truck (front)	27,680 lbs.
On truck (back)	46,700 lbs.
Total engine	215,180 lbs.
Total engine and tender (about)	345,000 lbs.

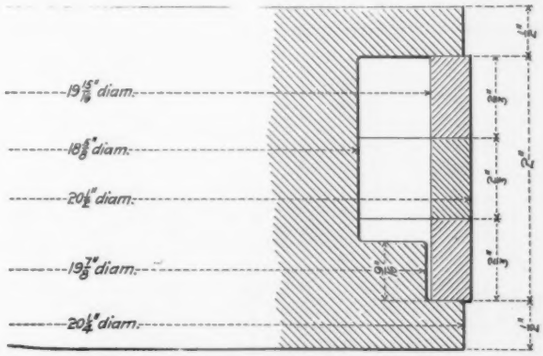
Tender.

Wheels—Number	8
Tank—Capacity	7,000 gals.
Service	Passenger

SOLID RINGS AND SOLID PISTONS.

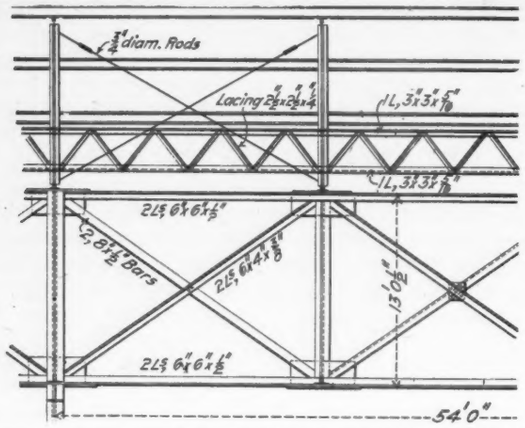
A great deal of interest has been aroused in England by a statement by Mr. A. F. Yarrow that for his engines he is using solid pistons and solid rings. *The Engineer*, of London, describes the construction and application of these rings. The construction is interesting and it could be used in many kinds of practice where high pressures are found. This would seem to be a good way to make packing for piston valves of locomotives. The following is quoted from a letter from Mr. Yarrow to the journal mentioned:

"Of course, at first sight it appears an impossibility to put the ring over the flange of the piston, the internal diameter of the ring being smaller than the outside diameter of the flange; but it is exactly the same thing as putting a half-crown through a hole the size of a shilling cut in a piece of paper. There is not the slightest difficulty in it. Of course, the rings have to be properly proportioned so as to get elasticity enough. I believe that having in view the early development of superheated steam, it becomes compulsory to have



A SOLID PISTON WITH THREE SOLID RINGS.

floating rings, and also compulsory that they should be uncut, so that any pressure of steam behind the ring should not press the ring against the inside of the cylinder. It has hitherto been thought that to have a solid floating ring one must have a junk ring, which adds weight and complication, and things that may work loose. A clearance of three or four or five thousandths of an inch is sufficient between the outside edge of the ring and the cylinder. A floating ring has the great advantage of accommodating itself to the form of a cylinder, which is not round throughout its whole length, as we all know, and in this respect the solid floating ring is very superior to the solid piston without any packing ring, which, of course, cannot accommodate itself to any ovaling of the cylinder."



DETAILS OF STEEL WORK FOR THE LONGITUDINAL BRACING OF THE BUILDINGS UPON CENTER LINES OF COLUMNS.

NEW LOCOMOTIVE AND CAR SHOPS.

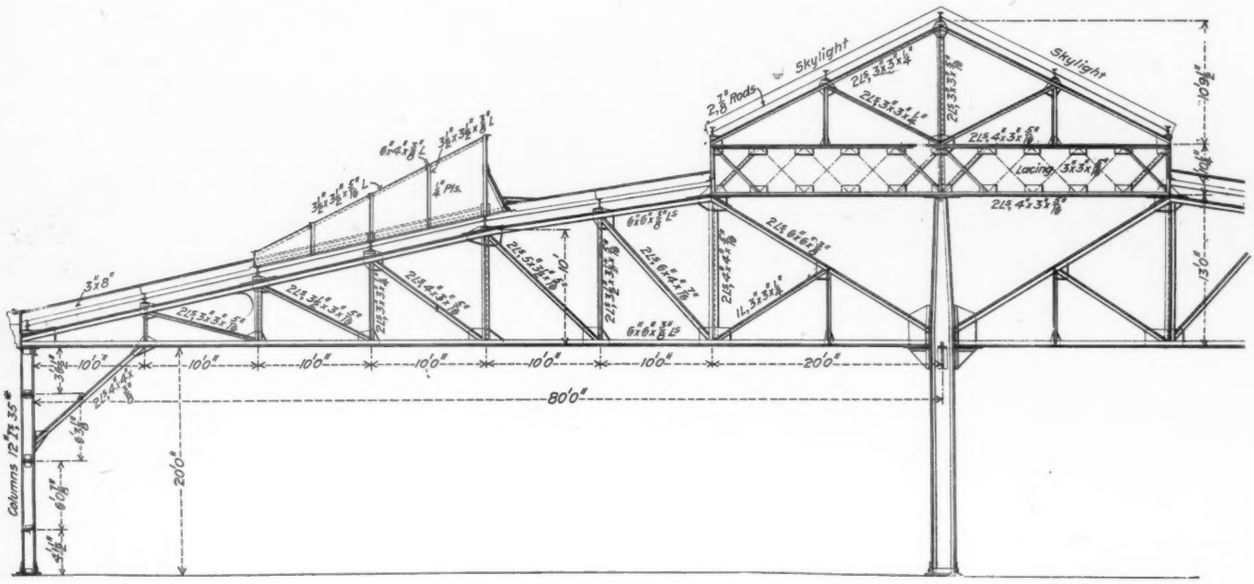
COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

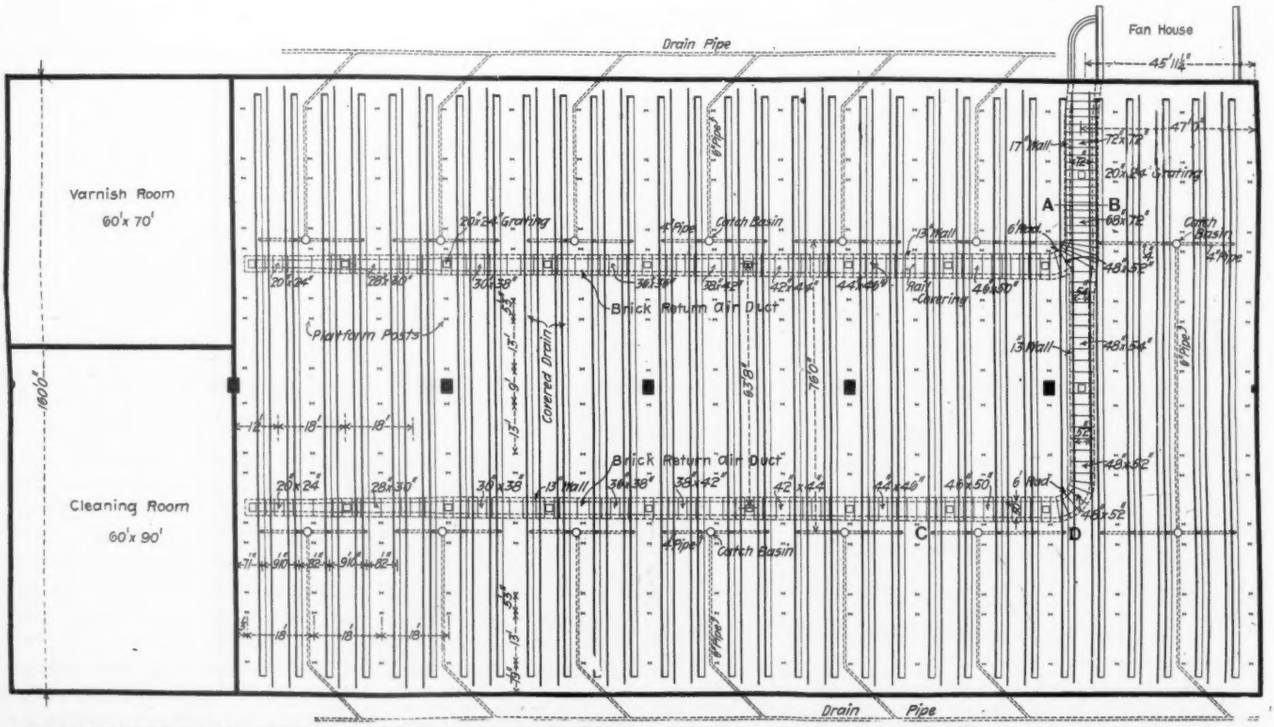
XIII.

CAR SHOP BUILDINGS.

These buildings are shown in the ground plan on page 408 They were designed by Mr. Albert Lucius, of New York, consulting engineer. The three principal buildings are arranged side by side and they are alike in their general features, such as the foundations, steel work and construction details, the only difference between them being in those features which must necessarily be varied to suit the special purposes to which each is put. For example the arrangement of the doors is



CROSS-SECTION, SHOWING STEEL CONSTRUCTION AS APPLIED TO BOTH FREIGHT AND PASSENGER DEPARTMENT BUILDINGS OF THE NEW CAR REPAIR SHOPS.



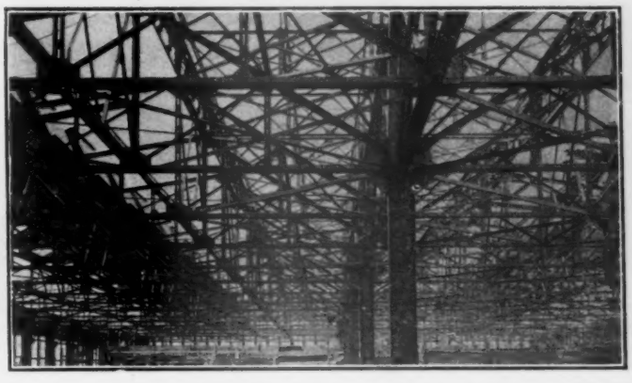
PLAN OF PASSENGER CAR PAINT SHOP, SHOWING ARRANGEMENT OF TRACKS, RETURN AIR DUCTS, DRAINS, PLATFORM POSTS, ETC.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

DETAIL VIEW OF THE NORTH END OF THE PASSENGER CAR PIANT SHOP.

VIEW OF THE NORTH END OF THE PASSENGER AND FREIGHT CAR REPAIR SHOPS.

DETAIL VIEW OF THE SOUTH END OF THE PASSENGER CAR PAINT SHOP.



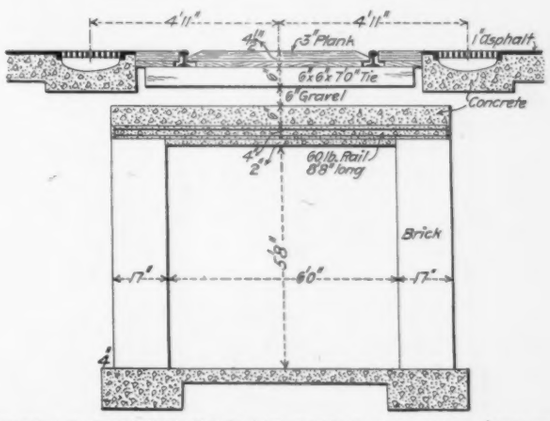
DETAIL INTERIOR CONSTRUCTION VIEW OF THE PASSENGER CAR PAINT SHOP.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

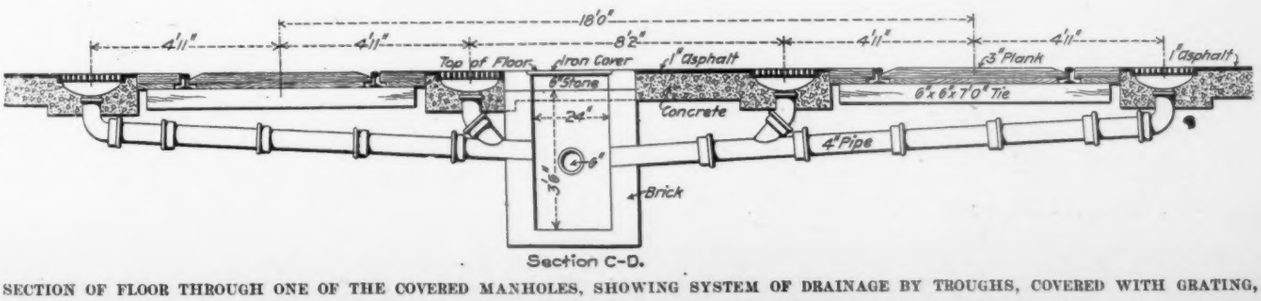
made to suit the tracks in each building and the amount of natural lighting is in accordance with the work which is done in each building. This feature of window and skylights is worthy of special attention. Better lighted buildings are very seldom, if ever seen in connection with railroad repair shops.

For example the total amount of glass in the sides and ends of the buildings amounts to 45 per cent. of the total areas of the walls and ends. The total glass area in these buildings is approximately equal to 75 per cent. of the total floor area. In the roof of the passenger car paint shop is a skylight, 42 ft. 4 in. wide by 245 ft. long in the monitor and to this is added 34 separate skylights 21 ft. by 11 ft. This gives an area of glass equal to 38 per cent. of the projected area of the roof. The passenger car repair shop has a skylight 22 ft. 4 in. by 335 ft. long, the full length of the building, and also 32, 11 by 11 ft, separate skylights, making 33 per cent. of the projected area of the roof. In the freight car repair shop, there is a skylight 37 ft. 4 in. by 333 ft. and 34 separate skylights, 12 ft. 3in. by 11 ft., making a total of 41 per cent. of the roof area. The planing mill has one 36 ft. 6 in. by 260 ft., making 45 per cent. of the roof area. In the photographs the large amount of glass area and its arrangement is clearly apparent. The sky lights are purposely given considerable rake in order to guard against leakage. This amounts to about one-quarter the height to the length of each skylight. This also applies to the monitor skylights and to this portion of the roofs of all the buildings, including the locomotive shops.

One cross section of the steel construction is illustrated.

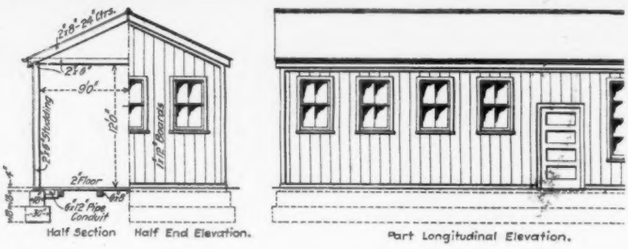


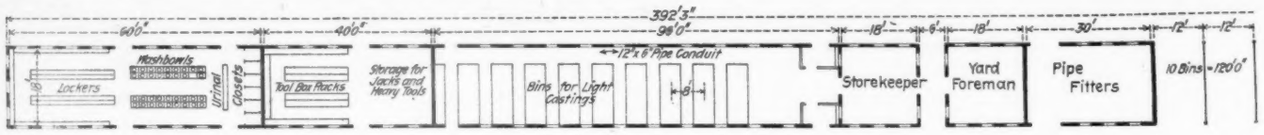
SECTION A-B, THROUGH FLOOR AND RETURN AIR DUCT. (SEE PLAN.)



SECTION OF FLOOR THROUGH ONE OF THE COVERED MANHOLES, SHOWING SYSTEM OF DRAINAGE BY TROUGHS, COVERED WITH GRATING, UNDER SIDES OF CARS. (SECTION C-D, SEE PLAN VIEW.)—PASSENGER CAR PAINT SHOP.

It represents all of the buildings. The center posts are built up of ½-inch plates, 24 in. wide, with four 6 by 4 by ½ in. angles placed 24 in. back to back. These are made wide in order to offer a large amount of wind resistance. Above the bottom chords of the roof trusses the posts taper off toward the top. At the walls the columns are of 12 in., 35 lb. I beams. The clear height under the roof trusses is 20 ft. and the roofs are particularly well braced against wind stresses, as indicated in the photographs, showing the steel work, before the construction was completed. The span on each side of the center posts





DETAIL PLAN AND ELEVATION OF OFFICE, STORAGE AND LAVATORY BUILDING IN THE CAR REPAIR YARD.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

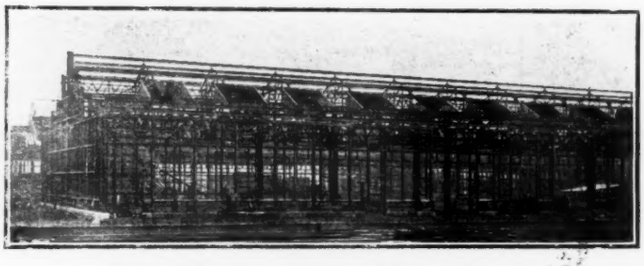
is 80 ft. and the roof trusses are spaced at eighteen ft. centers. The middle columns being spaced at 54 ft. centers. The roofs are of the "umbrella" type except that of the wood mill. All of the roofs are deep, giving a good proportion to the size and height of the buildings.

The center posts are placed on base stones 16 in. thick by 3 ft. 9 in. square and these rest on huge concrete foundations, in which the anchor bolts are set. The side and end foundations consist of the water table stones, 20 in. wide by 16 in. thick, resting on 27 in. stone sills, placed on concrete foundations.

For ventilation the monitor is fitted with 18 in. louvres, its full length on each side, these being fitted with opening devices operated from the floors of the building.

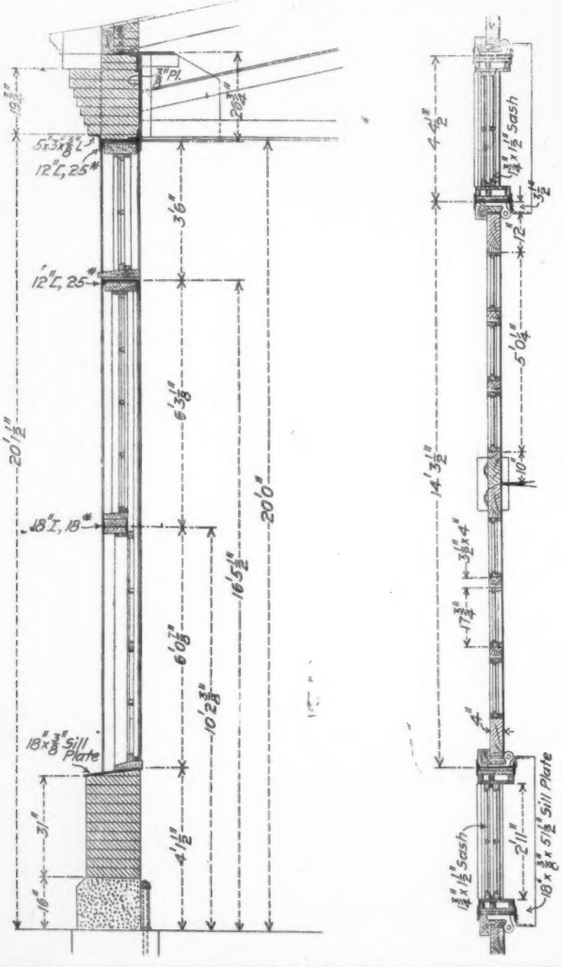
In connection with the plan view of the passenger car paint shop, a section of the floor and the drainage system is illustrated; this section is taken through one of the covered manholes. The plan shows the locations of the center posts, the tracks, the platform posts and the return ducts of the heating system, which are beneath the floor. The tracks are at 18 ft. centers and to this spacing all the depending features of the building are fitted.

Extending through the car repair yard, parallel to the tracks

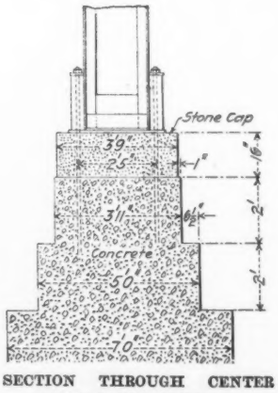


CONSTRUCTION VIEW OF THE PASSENGER CAR ERECTING SHOP. (FROM SOUTHEAST CORNER.

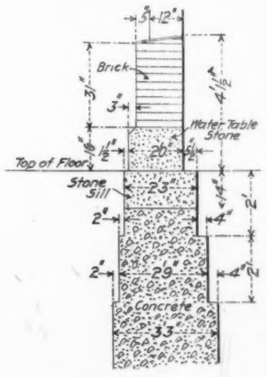
is a long low frame building, providing for the various small shops and storage spaces, necessary in a plant of this kind. The building has a span of 18 ft. and a clear height, inside, of 12 ft. Its total length is 392 ft. At the end toward the large shop buildings a 60 ft. lavatory space is provided. Next to this is a room 40 ft. long for the storage of tool boxes and heavy tools, such as jacks. Bins for light castings occupy a length of 96 ft. and the car yard storekeeper has an 18 ft. office at the end of this room. The remainder of the building provides an office for the yard foreman and a 30 ft. room for the pipe fitters. Beyond this are 10 bins for heavy castings, such as couplers, etc.



HORIZONTAL SECTION THROUGH SIDE OF BUILDING, SHOWING DETAILS OF WINDOWS AND DOORS, AND VERTICAL SECTION THROUGH WINDOWS.



SECTION THROUGH CENTER PIER FOUNDATIONS.



STANDARD SECTION FOR SIDE AND END FOUNDATIONS.

FOUNDATION DETAILS.

COLLINWOOD CAR SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

THE USE OF FLY WHEELS UPON MACHINE TOOLS.

BY J. C. STEEN.

A fly wheel, or balance wheel, in use may be considered as a means of applying stored energy to a mechanism. The application of energy thus stored, must necessarily be of short duration. As a matter of course, work is required to set a balance wheel in motion, but the amount of power required to keep such a wheel in motion, after once being started, is, however, relatively small.

In machine tool practice there are cases where stored energy can be used to advantage: First: Where the work done requires a considerable amount of power for a short time—the punching machine is an example of this class; Second: The use of stored energy may be of benefit where there is a comparatively rapid reversal of some movable part—as the ram of a shaper or slotter; Third: Any machine tool, that has rotating members which must be quickly reversed as to their direction of rotation, may require for a brief period the use of stored or reserve energy—the metal planing machine is an example of this class. The above noted machines do not cover the entire field, but will serve as illustrations of the principle involved.

The application of this stored energy to a machine tool may be had in two ways: The driving belt and driving pulley will, and do, in some cases, act as a form of stored energy; in other cases the addition of a separate balance wheel, as an auxiliary to the belt, is necessary. To determine the point where the energy of the running belt is sufficient, or where the addition of a separate wheel is advisable, it is essential that all operating conditions of the machine be known and understood. That which will answer in one case, may be wholly inefficient in another; or, the use of that which means success in one case may be a superfluity in another.

An example may be of interest. Some years ago a shaping machine was built which had extra weight added to the driving cone to serve as a balance wheel. The reserve force, or storage of energy, thus obtained came into excellent use, when the machine was used upon short strokes with a heavy cut, but it was wholly insufficient when used upon long strokes as the reserve energy was too quickly exhausted. In this particular case the design of the machine rendered the use of a balance wheel necessary. In the first place, the driving belt was somewhat lighter than is now the practice for this type of machine, and second, the Whitworth driving motion was so arranged that the starting of the cut was quite abrupt. In this case, the balance wheel effect of the heavy pulley, besides being a benefit when the machine was used upon short heavy cuts, served to relieve the light belt of the shock due to abrupt start of the tool into the work.

Certain types of slotting machines were at one time made with a fly wheel added to the driving shaft. Both shaping and slotting machines are in use which have this feature as a part of the machine.

With the more modern designs of shaping and slotting machines, whatever is needed in the way of a "balance of power" is obtained by the use of a somewhat heavy driving pulley, and wider and heavier driving belt than was at one time the practice; also a larger ratio of driving gears is now used than formerly, and, as higher belt speeds are necessary, the balance wheel effect thus obtained is usually sufficient. Besides, with this type of machine, the driving motion is, or should be, so arranged that both the beginning and ending of the cut take place with a moderate speed, the maximum rate of speed being at the center of length of the cut. These features, if properly looked after in the design of the machine, render the addition of a balance wheel unnecessary.

The above consideration apply to what are known as crank driven machines. Rack-driven shapers and slotters can be considered, in a measure, as being of the same class as planing machines, in as far as the conditions of driving are concerned.

With the operation of a planing machine, the quick reversals of direction of rotation of the driving pulleys, shaft and gears, as well as the changes in direction of the platen itself, render necessary the applications of considerable power for short periods of time. These increased amounts of power required, may be, and in some cases are greater than that required for either taking the cut or moving the platen and its load in the return direction. The excessive power demands at moments of reversal have at times caused quite a lot of trouble in the wear of belts, due to the heavy strains put upon them; countershafts have been hard to hold; the driving of nearby machines has at times been rendered unsteady; belts soon lose some of their holding quality as they glaze, owing to slippage.

Trouble due to this cause did not come all at once. It has grown as the planing machine has developed and for a time the cause was not apparent to all. This recalls to mind an occurrence which took place in the drawing room of a certain machine tool builder: Certain troubles had been reported, regarding the driving mechanism of their planers. The question as to the cause came up and an argumentative war was carried on between two factions among the draftsmen. One side believed that the reversal of platen caused the difficulty, while the other side held that the reversal of the driving pulley and accompanying rotating parts was to blame for the trouble. (Of course, this all took place when the chief was temporarily absent from the room.) The decision reached, was, that the pulley, principally, and platen, only partially, was at fault. With this view the chief coincided.

The reverse of the platen was unusually quick and a modification helped somewhat. The driving pulleys were of a heavy pattern; these were materially lightened, and other alterations were made in driving mechanism and the countershaft pulleys for the drive of the machine were made quite heavy, all of which led to an improved condition, and to the disappearance of former troubles.

An attempt made to stop a rapidly rotating pulley and to bring it to a high speed in the opposite direction, will convince anyone that in many cases there is needed, for the time being, an excess of power above that required for the usual operation of the machine. At such a time, the driving belt from the main line to the countershaft of the machine, is subjected to an extra heavy load, which can be relieved by the use of a balance wheel upon the countershaft. And this constitutes the principal, if not the only advantage derived from a balance wheel under these circumstances.

The fact that the severe work required at reversal is due more to the pulleys than to the platen, seems to have been ascertained by several concerns within relatively close periods of time. A year or two after the discussion, above noted, took place, word came that another planer concern, while experimenting along the line of quick return of platen, had arrived at the same conclusion, that the pulleys and accompanying rotating parts required more power at reversal than did the platen.

As to just when, where and just how much of a balance wheel is needed, depends mainly upon the design of the machine. In this connection planers seem to be the chief disturbers. One type of machine has very light pulleys, and a comparatively low gear ratio, and with these, a balance wheel is not much needed. Another type of machine works under similar conditions, with wide belts running at moderate speed and operates well by having the countershaft pulleys heavier than usual. Still another type of planer has a high ratio of gears, narrow belts and consequent high speed of the pulleys; with such machines, experience has shown the advantage of a balance wheel in connection with the countershaft.

With the high-speed class there is usually some slippage of belts, and, while the slippage serves to modify the severity of reversal, it is rough on the belts. Whenever this slipping of belts occurs, there is auricular evidence that "something is doing." For many years, most of the planer builders have followed to a greater or less extent the practice of making at least one of the countershaft pulleys quite heavy to act as a balance wheel.

As to the use of balance wheels upon motor-driven planers

or similar machines, the benefit derived will depend somewhat upon the motor used, and here also the different types of machines will have influence. With the motor, the excess energy required at reversal may or may not be detrimental to its action. Some motors seem to be able to take care of an extra load, momentarily applied, with ease; while others spark and flash at the brushes and show their reluctance to taking on any extra load quite plainly. This unsteady movement of energy at the motor may cause irregular action elsewhere and be objectionable on this account. If a properly proportioned balance wheel can be applied so that a smoother and better action of motor will result, then its use will be of advantage. Local conditions therefore, must determine for individual cases, whether the use of a balance wheel is advisable or not.

The above is given, not as a treatise, nor as being exhaustive of the subject, but mainly in answer to questions that have been recently brought forward.

REDUCING BEARING SURFACE TO CURE HOT BOXES.

In investigating trouble with hot boxes on a road running into Chicago it was found that the bearings were in contact with the journals upon more than one-quarter of the circumference. By reference to this diagram it will be seen that if

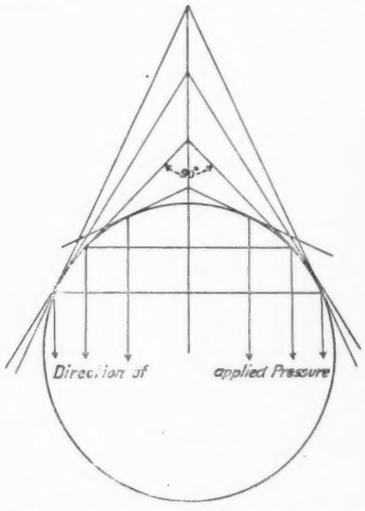


DIAGRAM INDICATING EFFECT OF TOO LARGE CONTACT BETWEEN JOURNAL AND BEARING.

the contact is one-quarter of the circumference, the tangents will form an acute angle, and consequently scraping and gripping will occur at the edges if a heavy load is applied to such a bearing. This is likely to prevent the oil from reaching the bearing surfaces and cause heating. In this case the trouble was entirely overcome by removing the excess of bearing surface. There were no oil holes in these bearings and no grooves. In the original bearings several huge sized grooves did not reduce the heating at all. This subject is also fully treated in a paper, "A Review on Alloys," read before the Western Railway Club, April, 1902, by Dr. Gustave Thurnauer.

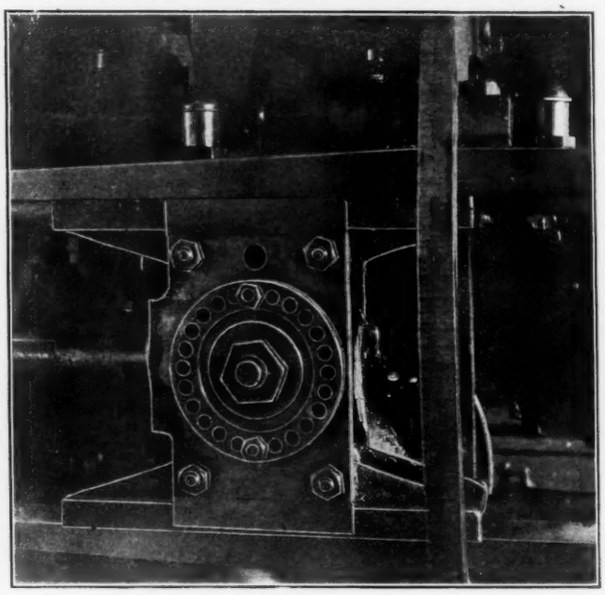
LOCKING DEVICE FOR CROSSHEAD PIN NUTS.

MICHIGAN CENTRAL RAILROAD.

The device which is illustrated in the accompanying engraving is the interesting result of what might have been a very serious accident to one of the new 4—4—2 type passenger engines on one of the Michigan divisions of the Michigan Central Railroad. Considerable difficulty had been experienced with the nuts on the crosshead pins becoming loose, in spite of the fact that jam nuts were used. The accident finally occurred in which one of these engines lost out one crosshead pin due to the main and jam nuts, both working loose and dropping off; the result was a badly bent main rod from dropping out of the crosshead, but fortunately the engine did not leave the rails and no one was hurt—this was remarkable, as the train was, at the time, running at a high rate of speed.

This trouble is now provided for by the use of the locking discs, or plates, as shown in the engraving. This device consists merely of a disc of steel with a hexagonal opening to fit over the main nut, and several holes near its outer periphery, by which it may be fastened up against the crosshead. In applying the disc, it is merely slipped over the main nut after it is tightened, and is then bolted in position by the machine bolts as shown. The disc does not interfere with the jam nut which is put on as usual.

This very simple device has proved very effective and is now



A NOVEL LOCKING DISC FOR CROSS-HEAD PIN NUTS.—MICHIGAN CENTRAL RAILROAD.

being applied to all engines having crosshead pins of this type. We are indebted to Mr. D. R. McBain, master mechanic, and Mr. M. D. Franey, foreman, of the locomotive repair shops of the Michigan Central, at Jackson, Mich., for this information.

THE ORIGINATOR OF SLEEPING CARS

Colonel R. E. Goodell died, in Denver, October 21. He was a conspicuous figure in the railway world in the fifties. At that time he was superintendent of the Chicago & Alton Railroad, and it was he who executed, on behalf of the railroad company, the first contract ever made with the late George M. Pullman for Pullman sleeping cars. It was largely through Colonel Goodell's influence and sagacity that this first recognition of Mr. Pullman's sleeping cars was made which gave the "Alton" the distinction of being the pioneer sleeping car line. There were three different makes of sleeping cars originally submitted to Colonel Goodell for his choice, and after examining all patterns, the choice fell to Mr. Pullman. Colonel Goodell took Mr. Pullman to Bloomington, at which point the Chicago & Alton erecting shops then and now are located, and from two Chicago & Alton passenger coaches the first Pullmans were constructed. The first contract provided that the "C. & A." was to furnish the cars and keep up the outside, and that Mr. Pullman was to furnish and keep up the inside. While Mr. Pullman provided the drawings and patterns for his first cars, Colonel Goodell's recommendations, as the cars were under reconstruction, were exceedingly valuable to Mr. Pullman, and the friendship between the two men, formed at that time, continued until Mr. Pullman's death.

AN EXTENSIVE WATER SOFTENING INSTALLATION.

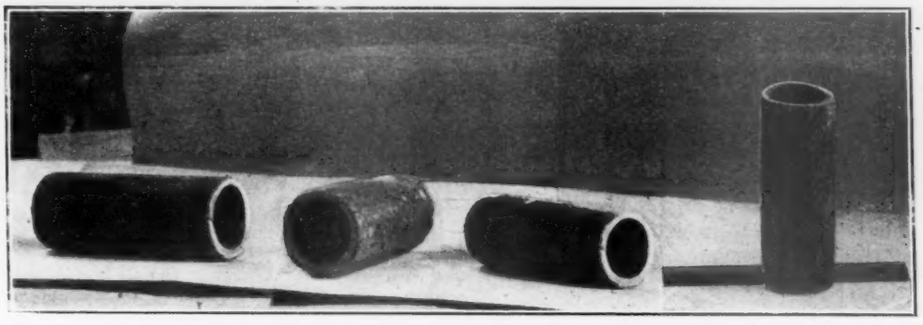
TOTAL CAPACITY, 348,000 GALLONS PER HOUR.

PITTSBURGH & LAKE ERIE RAILROAD.

II.

(*Continued from page* 401.)

The provision of good boiler waters is of the first importance as an operating problem. To be sure the question of economy in repairs is also important. On such a road as the Pittsburg & Lake Erie with an enormous and exacting traffic centering in such a city as Pittsburgh, the first requisite of the locomotive is that it shall be powerful and that its power shall be continuously available for service. Large capacity has been sought in some cases by merely increasing the dimensions and weights of engines, but this plan soon reaches physical limits and it does not avoid the loss of service because of boiler repairs due to bad water. When the water question is satisfactorily solved the matter of ultimate capacity may be taken up and water which is good for small boilers is also good for large ones. The plan of this road seems to be admirable because it promises to secure the utmost boiler capacity combined with continuous service of the present equipment, and furthermore, all other efforts to increase capacity are still available. Any principle tending toward obtaining the maximum possible results from present equipment appeals to us as right from a business, as well as from an engineering, standpoint and water purification seems to be the problem to which motive power and engineering talent can be most profitably applied at this time.



SAMPLES OF SCALED BOILER TUBES, TAKEN FROM LOCOMOTIVES OF THE PITTSBURGH & LAKE ERIE RAILROAD, AFTER 12 MONTHS OF SERVICE WITH THE UNTREATED WATER.

It is difficult to realize fully the extent to which the use of natural waters, containing scale-forming impurities, for locomotive water supply, influences the problem of caring for and maintaining locomotive boilers upon our railroads. The difficulties imposed by the formation and accumulation of scale upon the heating surfaces of boilers have, through the many years of use of steam power, come to be regarded as a necessary evil which cannot be avoided and which must be regularly provided for with care. It is the usual practice of most of our railroads to liberally provide for frequent and extensive boiler repairs and renewals, but the extra expense involved in this element of maintenance is incapable of exact determination on account of the complication and inter-connection of details—it is the experience, however, of all motive power officials that this element is very expensive and involved, and has been considered an unavoidable factor in the problem of locomotive maintenance.

The possibilities for economies that exist in the use of the water treatment system for removing the scale-forming impurities from the boiler-feed water, are thus almost beyond comprehension. Few have given this subject the consideration that it deserves and little is known, also, of the benefits to be derived. This subject was investigated with great care and analyzed most completely by the management of the Pittsburgh & Lake Erie Railroad under the direct supervision of the Engineering Department. Some of the considerations which led to the adoption of water purifying plants on a large scale on this progressive road may be of interest.

On account of the use of scale forming waters, and also of water containing free sulphuric acid, it will be admitted that bad results will inevitably come. These results may be summed up as follows:

First: Loss of fuel due to the insulating effect of scale on the flue and other heating surfaces.

Second: Loss in service of locomotives due to time required for making repairs, weekly, monthly and annually, directly chargeable to bad water conditions.

Third: Additional round house and shop expenses, due to the above work, for material and labor.

The above items will, of course, have different money values on different roads varying with the conditions; but on the Pittsburgh and Lake Erie the amounts have been estimated as stated below:

First Item: "Loss of fuel due to effect of scale, etc.":

A great deal of careful investigation has been given to the determination of the efficiency of the heating surfaces of boilers when clean and when coated with scale, and, in this connection the remarkable uniformity of the results of all such investigation is worthy of note.

In Clark's "Steam Engine," volume 1, page 218, it is stated that "a scale of a sulphate of lime 1-16 in. thick reduced the efficiency 14.7%" (as determined in a series of experiments upon a boiler). Dr. J. C. Rogers states, in the volume entitled, "Water Purification," that a scale 1-16 in. thick makes 15% more fuel necessary than with clean heating surfaces and furthermore that this ratio increases as the scale thickens. This authority also estimates the heat conductivity of boiler incrustation to bear a relation to that of wrought iron plate of 1 to 37.5. The authority, Rankine, states in his work on "Steam Engines" that the specific heat of carbonate of lime is 18 times that of iron, and that of sulphate of lime is 15 times that of iron; it is stated that the consequent waste in urging a fire for steam raising in a scaled boiler is enormous, as it is estimated that 1-16 in. of scale requires the use of 16% more fuel, while a scale ¼ in. thick will necessitate 50% more fuel, and ½ in. of scale 150% more fuel. A noted foreign authority, Fischer's Chemisch Technologie des Wassers, page 216, states that Reuben Wells ran two engines for several months with heating surfaces covered with scale and an equal length of time later with clean heating surfaces, and found a saving of 17½% with the clean boiler.

The remarkable uniformity of these few of the many tests that have been made in this direction tend to verify the general proposition that 1-16 in. of scale on the heating surfaces of a boiler will increase the fuel required to be burned to maintain a given temperature on the water side of the surface by approximately 14% to 17%—say 15%.

By careful investigation it has been determined that the average condition of a boiler will show at least ⅛ of an inch of scale upon the heating surfaces. The nature of the scale that forms in the boilers may be judged from the accompanying photographs of sections of boiler tubes that were selected

as samples to show the average conditions met in practice. These tubes had been in service about a year before they were removed. The average thickness of scale on these samples is ⅛ in., although on the bottom edge it measured 3-16 in. thick. The scale is of a very hard nature, the scale forming materials evidently having strong cementing properties. The color is light brown.

This matter has been brought to the attention of several prominent motive power officials and the unanimous opinion is that ⅛ of an in. is a very conservative estimate of the average thickness of scale on different roads throughout the country. Therefore by assuming this to be true we find that on an average 30% of the fuel used has been wasted due to scale. These figures might probably be safely used, but in order that the estimate may be *under*, rather than over, actual conditions we will use only one-half this amount, or 15%, and still find the estimated loss due to this cause on the P. & L. E. R. R. amounting to about $50,000 per year—using the amount of fuel coal reported in annual report for the last fiscal year.

Second Item: "Loss in service of locomotives, etc.":

This loss has been estimated to amount to about 1-12 of the total time of the locomotive, taking into account the many times the flues and fire boxes require to have "boiler work" done on them, and also the fact that new flues have to be put in about once in every 10 months.

Putting this estimate, which is also placed on the conservative side, in plain figures, it means that on this road the company is losing constantly the use of $230,000 invested in locomotives that are unproductive on account of bad water. It would be quite reasonable to estimate this loss by using the *earning power* of the locomotive, as for a considerable time during the past two years the *locomotive capacity* measured the capacity of the road to do business; but as this would lead to *enormous* figures we will use the very conservative method by estimating simply the interest on the investment, using 5% for interest and 5% for depreciation which makes the annual loss through locomotives being out of service amount to $23,000.

Third Item: "Loss due to shop expenses on locomotives due to bad water troubles":

This item is somewhat indefinite, but taking into account labor, material and proper charge for use of shop facilities it has been estimated to amount to $100 per locomotive per year, making a total loss on this road of $20,000 per year.

Summing up these items we have an estimated loss per year of $93,000 due to bad water conditions, which is a *very* conservative estimate.

It cannot be hoped that any system of water purification now on the market will allow all of these bad conditions to be gotten away from entirely, without some expense, and probably losses in other directions; but the enormous amounts of these losses have been considered sufficient warrant for an investment in water purifying plants for the entire road.

Results are now being had which will determine whether the investment will produce the economies as described.

These results will be given in later issues.

A CAR SHOP WHEEL HOIST AND TRAVERSER.

This wheel hoist is at the Englewood car shops of the Lake Shore & Michigan Southern, and is arranged between two buildings, the one on the right being the machine shop. Wheels are run in from the yard, and as the hoist is traversed along the runway by a chain, any pair of wheels may be taken to the machine-shop door, turned and run into the building on a track. The air-cylinder is 8½ x 44 ins. controlled by handles, and the air is brought to it by a hose carried in loops by small carrier pulleys 15 ft. apart. The chain is endless, and is driven from an extended line-shaft, the clutch being operated from the machine-shop door. To traverse in one direction the cylinder carriage is clutched to the upper chain, and to drive it in the opposite direction it is connected to the lower one. This clutch is operated by cords. At first a wire cable was used for traversing, but this has been replaced by a ⅜-in. plain iron chain, which is adjusted as to length by a sheave on a swinging hanger. The device is very convenient, and saves a material amount of labor in handling wheels. It is specially valuable when a rush order of wheels must be handled in the shop when the trackway happens to be full. The device was arranged by Mr. L. G. Parish, master carbuilder of the L. S. & M. S. at Englewood.

WHEEL HOIST AND TRAVERSER AT THE ENGLEWOOD SHOPS, LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

ELECTRIC TRACTION EQUIPMENT FOR THE NEW YORK CENTRAL.

The New York Central & Hudson River R. R. Co., have just placed an order with the General Electric Company for eight turbo-generators of a capacity of 7,500 h.p. each. The turbines are of the 4-stage-vertical-Curtis-type, and the generators are 25 cycle, 3-phase alternators, to generate current at a pressure of 11,000 volts. This is by far the largest order for steam turbines that has ever been placed in this country or abroad. The New York Central Company has placed with the General Electric Company, in co operation with the Schenectady Works of the American Locomotive Company, an order for 30 electric locomotives. These locomotives are of an entirely new design. They will weigh 85 tons each, with an adhesive weight on the drivers of 67 tons. Each locomotive will have a capacity of 2,200 h.p., and will be capable of hauling a train of 500 tons at a speed of 60 miles an hour. This order has also the distinction of being by far the largest order for electric locomotives ever placed in *any* country.

COMMUNICATIONS.

TWO SPECIALLY IMPORTANT FEATURES OF BALANCED COMPOUND LOCOMOTIVES.

To the Editor:

During the past eighteen months the AMERICAN ENGINEER AND RAILROAD JOURNAL has published several valuable articles upon the Vauclain and the de Glehn systems of 4-cylinder balanced compound locomotives, but I do not recall any reference having been made to two very important advantages possessed by these engines over the ordinary 2-crank locomotive, namely: (1) The higher value of the normal coefficient of adhesion, and (2) the greater uniformity of the tractive force developed during each revolution of the driving-wheels. Since these characteristics of the balanced locomotive have, to a considerable extent, enabled it to regularly perform work in Europe for which in this country an engine of some 20 per cent. greater weight is required, I beg leave to direct special attention to them.

In any 2-crank locomotive, whether of the single-expansion, 2-cylinder compound, Vauclain, or tandem compound type, the turning moments, as is well known, vary greatly throughout the revolution, attaining their maximum theoretical value when the two cranks are in front of the axle and stand at angles of 45 degs. with horizontal or vertical lines, and decreasing from thence to the dead points, where the rotative effort falls to a minimum.

With a locomotive having four cranks set at 90 degs. to each other, the turning moments are, obviously, much more uniform than in an ordinary engine, and practically approximate very closely to the results obtained from an electric motor drive.

Now, "it is indisputable that driving-wheels with variable turning moments are much more likely to slip than those whose effort on the rails is fairly constant. A wheel begins to slip when the effort is at a maximum, which would not slip with the average effort. Once slipping begins, static friction, whose coefficient is much higher than that of dynamic friction, is lost, and the wheel once started will go on slipping. Here we have the reason why the motor bogie has apparently a higher coefficient of adhesion than has the steam locomotive." (*The Engineer*, October 30, 1903.)

To this tendency to slip caused by the variable rotative effort of the 2-crank engine must be added that due to the variation (frequently of many thousand pounds) of the effective adhesive weight during each revolution of the driving-wheels, resulting from the vertical component of the centrifugal force developed by the weights employed to partially neutralize the inertia effects of the reciprocating masses. This disturbance is, of course, entirely avoided in the balanced locomotive, and a practically constant adhesive force is thereby obtained.

The combined effect of this uniformity in the rotative effort, and in the wheel pressure of the 4-crank locomotive, is that its coefficient of adhesion is considerably greater than that of the ordinary engine. Quoting again from *The Engineer:* "The normal coefficient of adhesion in this country (England) is taken at one-sixth of the insistent weight on the drivers; we have reason to believe that with Mr. de Glehn's engine it is not less than one-fifth, or possibly more."

From this it follows that in addition to the greatly increased driving-wheel loads rendered practicable and safe by the suppression of all balancing of the reciprocating parts of the engine, the 4-crank locomotive enables a *greater proportion of the given adhesive weight to be utilized by the cylinders, and to appear as effective tractive force*, than is possible with any other type of engine.

Furthermore, the greater uniformity in the turning moments of the 4-crank than of the 2-crank locomotive, together with the elimination of the longitudinal disturbances due to the unbalanced portion of the reciprocating parts, necessarily results in a correspondingly greater uniformity in the draw-bar stress of the former than of the latter engine; the importance of which uniformity will be apparent when it is remembered that experience seems to prove beyond all dispute that a locomotive with a steady tractive effort will haul heavier and faster trains than one whose pull, although of equal mean intensity, rises and falls in amount.

From the foregoing it appears that both as regards its normal coefficient of adhesion, and its uniform tractive force, the 4-cylinder balanced compound locomotive approximates quite closely to the electric motor, and since the latter constitutes the most efficient method of railway propulsion now known, this similarity indicates that in at least two important particulars this type of engine approaches perfection.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.

25 Broad Street, New York.
November 17, 1903.

MODERN SMOKE BOX PRACTICE NOW UNDERSTOOD ABROAD.

To the Editor:

Mons. Edouard Sauvage, the prominent French motive power engineer and author of a very complete and useful treatise on the locomotive boiler, has recently published another work of interest, "Les Locomotives au Debut du XXme Siecle" (Locomotives at the beginning of the 20th Century). This book, which has not been translated and does not seem to have been reviewed by any of our technical journals, illustrates numerous examples of the most recent practice both here and in Europe, the only criticism which seems applicable to its presentation of our own being that it is deficient as to any instances of the suburban engines of the Forney type and the heavy shifting engines which have been recently introduced in the United States. The leading examples of present European practice also appear to be included, and a comparison of the book with a German publication of about the same date, "Die Lokomotiven," by von Borries and others, indicates that the latter authors have not gone any more fully into the subject of European practice.

The following translation, which the writer has made as literal as possible, of M. Sauvage's remarks on the subject of smoke boxes, on page 13 of his book, shows that European engineers are now obtaining a correct understanding of the basic and underlying fallacy of the extended smoke box system, and warrants the belief that they will follow the latest and best examples of American practice in abandoning it, without undergoing our lengthy and costly demonstration of its disadvantages.

"Smoke boxes were formerly as small as possible. Since the last ten years they have applied very much in Europe the extended smoke box, of a length of nearly 2 metres, which originated in America. By reason of its vast capacity it can collect a great quantity of cinders, drawn into it by the active draught, without causing the accumulated cinders to obstruct the discharge from the tubes. European engineers have recently learned, with a certain surprise, that a return to the box of smaller dimensions appears to be produced in America, while they extended the applications of the expanded box. Observe the motives of this new American practice. Combustion was pushed so far in the United States that the entrainments of cinders are enormous; no smoke box, whatever its capacity might be, would serve to hold all of them. Of what use then was it to keep a portion? They have then adopted the plan of so disposing the apparatus that the cinders may be thrown out of the stack, always after having been broken up by striking against the surfaces of the smoke box, in order to avoid the throwing out of large pieces which could set out fires."

It is a matter of surprise that so long a time was occupied and so much money wasted in this country, in ascertaining the fact, which ought to be an obvious one, that an extended smoke box, unless made of such "vast capacity" as to be absolutely impracticable, cannot hold any substantial fraction of the cinders that are drawn through the tubes, and that this being the case, it is practically as well to have all of them thrown out as to retain only the small portion of them which will bank up against the front of the extension. European engineers having now observed the recognition of these facts in our latest and most intelligent practice, will not be slow to recognize not only that an extended smoke box does *not* serve as a receptable to carry any material portions of the cinders (regardless of the character of the combustion in the firebox), but also that it involves the attendant disadvantages of increased cost, weight and impairment of free steaming. We are dropping the "fad" after a long and expensive experience with it, and they have the advantage that their mistake in adopting it will require infinitely less time and money for its correction.

J. SNOWDEN BELL.

Pittsburgh, November 11, 1903.

In discussing the dangerous practice of plugging staybolts in the November number of this journal, it was stated that "the well known hollow staybolts cannot be plugged from the outside without putting the fire out." This needs a little explanation, because it was not understood by at least one of our readers. The intention of the writer of that statement was to say that a hollow staybolt cannot be plugged from the outside without sending steam through the broken bolt to the inside of the firebox. This journal is edited for the high-class motive power official, and it is inconceivable that anyone who cares to read it would be guilty of such a criminal act as to plug a staybolt under any circumstances. We wished to point out, however, the difficulty of performing such an abominable trick in the case of a hollow staybolt.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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247 new subscriptions received in this office during the month of November.

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Mr. G. M. Basford, editor of this journal, sailed Nov. 21st, for the trip to Europe, as noted in our editorial columns of the preceding issue. He will remain abroad about ten weeks.

The president of a well-known railroad makes a practice of using the technical journals in a way which might well be followed by others. He is a systematic reader of the papers and makes a practice of marking articles referring to the operation of the various departments and calling the attention of the heads of the departments to such as he finds specially interesting or suggestive. If done in a broad-minded way this is an excellent plan, and one from which important results may be obtained. The president, however, is not the only officer who may use this method effectively. A Western master mechanic does practically the same thing among his foremen and shop men. He marks articles and sends them with a letter to certain men, asking for a written opinion upon the applicability of the suggestion contained in the article to the local conditions. In this case it is not the opinion that is desired so much as the assurance that the papers are read and the suggestions noticed. This officer finds this plan so satisfactory that he is to extend it and bring the technical papers into the discussions at the meetings of the foremen and shop men, which he holds at regular intervals.

Those who are responsible for the design of locomotives for present day conditions of service should bear in mind the fact that they are not building for to-day alone, but for the next twenty years. For this reason it is important to provide sufficient capacity to guard against the possibility of finding it necessary to ultimately convert locomotives to another type or discard them altogether, because they are inadequate for economical performance. A freight locomotive with 17-in. cylinders, carrying 140 lbs. steam pressure is almost entirely useless to-day if it be of a type which does not readily lend itself to conversion into a switch engine; yet many such locomotives are still in service. To many general managers a locomotive is a locomotive, and it is not always easy to secure approval of the "scrapping" of old engines, although such a course is obviously correct from a business standpoint. It is possible to build locomotives to designs which will insure economical service to the end, but this requires a long look into the future. The present experience of a number of roads indicates the importance of using the greatest possible skill in original designs in order to keep locomotive equipment up to advancing requirements. To properly design locomotives to-day requires a high grade of ability, experience and knowledge of operating conditions. In this function motive power superintendents are called upon to exercise a degree of skill and ability which was formerly not needed. With the tendency of the time toward concentration of ownership it may be said that too much care cannot be taken in the development of every new design which is to remain for years as an indication of the character of business ability of those in responsible charge. In this matter a lesson lies not deeply hidden, to the effect that it would be well to magnify the importance of the officers who are directly in charge of this important work.

PROMOTION FROM THE RANKS.

Most people are not satisfied with their situation in life, and if it were not so there would be little or no progress or improvement in any direction. Dissatisfaction with what we are and what we have is the incentive to do better things. Therefore dissatisfaction in this sense is a good thing. If a man is satisfied to perform the same service for twenty years, in the same way and with no improvement in position or compensation he is not fit even for that position and must eventually move backward. Those who are responsible for the work of many men may take this dissatisfaction for granted and neglect it. They are the men who are unable to retain the service of good men. They deserve to lose every good man.

On the other hand they may take advantage of it to promote and encourage every man who is dissatisfied enough to improve his work and prepare for greater responsibilities.

Herein is the success of men like Carnegie, and herein lies the failure of many large concerns to secure and keep the right sort of men. Railroads can be mentioned on which this principle has not taken a strong growth. In such cases important positions are always filled with "new blood." The old blood understands this policy to mean that hope of advancement and promotion is cut off from all who cannot bring strong influence to bear upon their own interests, and few are able to do this.

This situation is not only unbusiness-like, but it is positively dangerous to the advancement of those who are responsible for it. How can an organization of discouraged subordinates accomplish good work? It is impossible to do "good railroading" under any such conditions. Those who are making the fatal mistake of neglecting the principle of promotion from the ranks should give this matter a thought and rectify it before it is too late.

VARIABLE-SPEED DRIVES AND FEEDS.

The opinion is held by some that the introduction of the positive-drive speed-changing mechanism for the feeds and drives of machine tools, which is being resorted to by progressive tool builders, is being overdone—that too many speeds are usually provided for, etc. In one instance a contemporary states editorially, that "a reversion is noted in some orders recently placed in that the specifications call for but two or three possible changes of speed."

We believe, however, that the variable speed mechanism has not been introduced nearly to the extent that its advantages justify and, further, that the advantages of its use are far from being sufficiently appreciated; this belief is fully sustained by the fact that all of our more progressive tool builders, in this country, are using and perfecting such devices wherever it is possible to use them, and again by the fact that the English and other foreign tool builders have been doing so for some time. The fact, that "in some orders recently placed" only two or three speed changes are called for, does not indicate a "reversion" from the use of this improvement, but rather a further step in progress, in that the tools are to be specialized for the work in which they are to be used. This is as commendable as is the use of the speed changing mechanism.

Where tools are to be used for varying classes of work, such as is the case with drilling machines and lathes (unless specialized) the provision of speed changes in the drives, either by variable speed motors, or mechanically, is absolutely essential for progressive and time-saving machining operations, and any statement to the effect that "the best way to insure the best cutting speed to be maintained would appear to lie in taking from the workman the ability to vary such speed," is absolutely wrong.

PERSONALS.

Mr. John Cullinan has resigned as master mechanic of the Pennsylvania lines at Toledo, Ohio.

Mr. W. E. Anderson, master mechanic of the Chicago, Rock Island & Pacific at Goodland, Kansas, has resigned.

Mr. R. M. Crown has been appointed superintendent of motive power of the Warren & Corsicana Pacific, with office at Warren, Texas.

Mr. P. H. McGuire has been appointed master mechanic of the Great Northern, with headquarters at Superior, Wis., succeeding Mr. G. A. Bruce.

Mr. A. L. Robinson has been appointed master mechanic of the St. Louis-Louisville lines of the Southern Ry., with headquarters at Princeton, Ind.

Mr. R. S. Wickersham has resigned as assistant engineer of tests of the Sante Fe, to enter the service of the Chicago & Northwestern as roundhouse foreman at Hawarden, Iowa.

Mr. T. M. Ramsdell has resigned as chief car inspector of the Sante Fe to accept the position of master car builder of the Chesapeake & Ohio, with headquarters at Huntington, W. Va.

Mr. C. Kyle, formerly master mechanic of the Algoma Central & Hudson Bay, is now master mechanic of the Lake Superior division of the Canadian Pacific, with headquarters at North Bay, Ont.

Mr. F. C. Cleaver has been appointed superintendent of motive power and rolling stock of the Rutland Railroad, to succeed Mr. P. T. Lonergan, resigned. His headquarters are at Rutland, Vt.

Mr. W. D. Watkins has been promoted from the position of traveling engineer on the Illinois Central to that of master mechanic, with headquarters at Water Valley, Miss., succeeding Mr. J. F. Price, resigned.

Mr. Charles H. Hines has been appointed electrical engineer of the Canadian Pacific Railway, with office in Montreal. He has general charge of the electrical works, such as lighting and power, for the entire road.

Mr. Charles A. Goodnow, who recently resigned as general manager of the Chicago, Rock Island & Pacific, has been appointed general manager of the Chicago & Alton. Mr. James H. Barrett, general superintendent of the latter company, has resigned.

Mr. Philip Reeves, heretofore general foreman of the Baltimore & Ohio Southwestern, at Chillicothe, O., has been appointed master mechanic at that point to succeed Mr. F. J. Smith, who has been transferred to Washington, Ind., in the same capacity.

Mr. J. G. Neuffer has accepted the position of assistant superintendent of machinery of the Illinois Central Railroad, with office in Chicago. He has resigned as superintendent of motive power of the Baltimore & Ohio Southwestern after having been connected with that road for 30 years.

Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie was chosen as president of the Railway Club of Pittsburgh, at its recent meeting, and Mr. F. T. Hyndman, master mechanic of the Buffalo, Rochester & Pittsburgh at Du Bois, Pa., was elected vice-president. Mr. J. D. McIlwain was re-elected as treasurer.

Mr. Elliot Sumner has been appointed assistant engineer of motive power of the Pennsylvania R. R., at Altoona, Pa., succeeding to the position recently made vacant by the transfer of Mr. I. B. Thomas to Pittsburgh, Pa., as master mechanic. Mr. Sumner heretofore has held the position as assistant engineer of motive power at Buffalo, N. Y.

Mr. John Hair has been promoted from the position of master mechanic of the Baltimore & Ohio Southwestern at Washington, Ind., to succeed Mr. J. G. Neuffer as superintendent of motive power, with headquarters at Cincinnati, Ohio. Mr. Hair is succeeded at Washington, Ind., by Mr. F. J. Smith, master mechanic at Chillicothe, Ohio, and Mr. Smith is succeeded at that point by Mr. Philip Reeves, general foreman.

Mr. Clarence P. Day has accepted the position of manager of the eastern business interests of *The Railway and Engineering Review* of Chicago, with headquarters at 140 Nassau street, New York. His many friends will be pleased to know that he has returned to this field in which he has spent so many years and in which he has been so successful. Mr. Day will have charge of all of the territory east of Pittsburgh.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

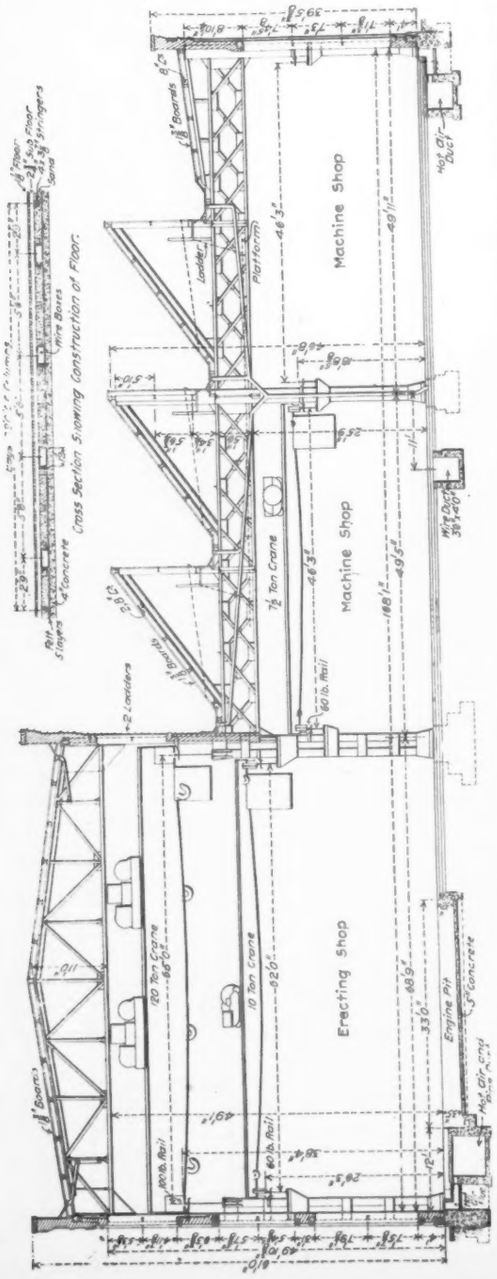
PITTSBURGH & LAKE ERIE RAILROAD.

II.

ERECTING AND MACHINE SHOP.

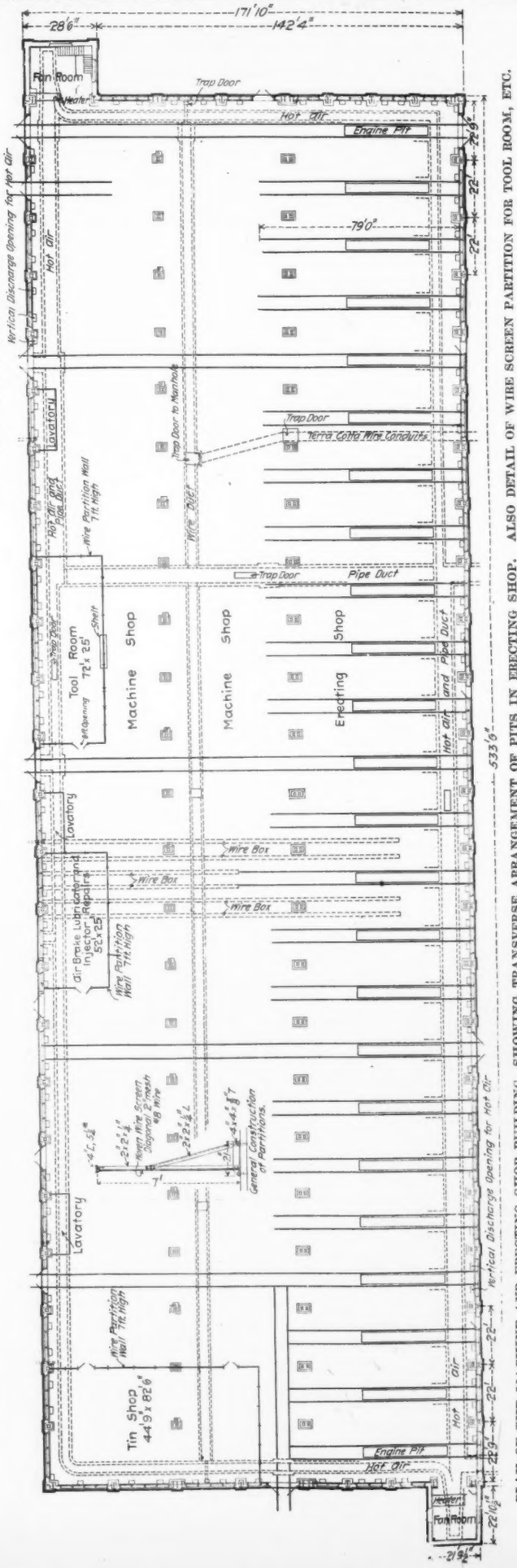
In this article the details of building construction for the combined locomotive and erecting shop building will be presented. An excellent idea may be gained of the proportions of this building by reference to the exterior and interior views, which are reproduced in the accompanying engravings. The exterior view, the photo for which was taken from the bluff at the rear of the shops, well illustrates the attractive architectural result from the brickwork enclosure of the steel work and from the carefully designed cornice, as well as also the excellent provision for daylight lighting. The entire building, both erecting and machine shop portions, present a most symmetrical and pleasing appearance.

The building is of the modern steel-skeleton construction,



CROSS SECTION OF THE COMBINED ERECTING AND MACHINE SHOP, SHOWING ARRANGEMENT OF CRANES AND DETAILS OF ROOF CONSTRUCTION.

(Longitudinal Section of Floor, Showing Construction and Scheme of Wire Boxes, in Detail Sketch Above.)



PLAN OF THE MACHINE AND ERECTING SHOP BUILDING, SHOWING TRANSVERSE ARRANGEMENT OF PITS IN ERECTING SHOP. ALSO DETAIL OF WIRE SCREEN PARTITION FOR TOOL ROOM, ETC.

NEW LOCOMOTIVE SHOPS AT McKEES ROCKS.—PITTSBURGH & LAKE ERIE RAILROAD.

with 18 in. walls and brickwork pilasters between the windows, enclosing the frame columns of the building. The brickwork of the building is tied to the steel, but is otherwise entirely independent. The foundations are of concrete throughout.

The building is of great length, 533 ft. long, and is divided into three bays by the longitudinal rows of columns, as shown in the plan view. The erecting shop, which occupies the bay at the south side of the building, is 68 ft. 9 in. wide; the machine shop occupies the two other bays on the north side, one 49 ft. 5 in., and other 49 ft. 11 in. The steel columns are symmetrically placed throughout the building, the spacing being in all cases 22 ft. between centers, except at the extreme east and west ends of the building, where it is 22 ft. 9 in. The distances between erecting shop pit centers is 22 ft. in each case. The steel work for this building was designed by Mr. Albert Lucius, of New York, and was erected by the McClintock-Marshall Construction Company, Pittsburgh, Pa.

THE STEEL WORK.

The substantial character of the steel work in the framing may be judged from the interior views as well as from the cross-section. The general plan of the steel work and its longitudinal bracing is similar to that made use of in the locomotive shop building at the Collinwood shops of the Lake Shore & Michigan Southern, (see page 366, December, 1902). Longitudinal bracing is provided between columns in alternate bays, with expansion bays between, like a trestle.

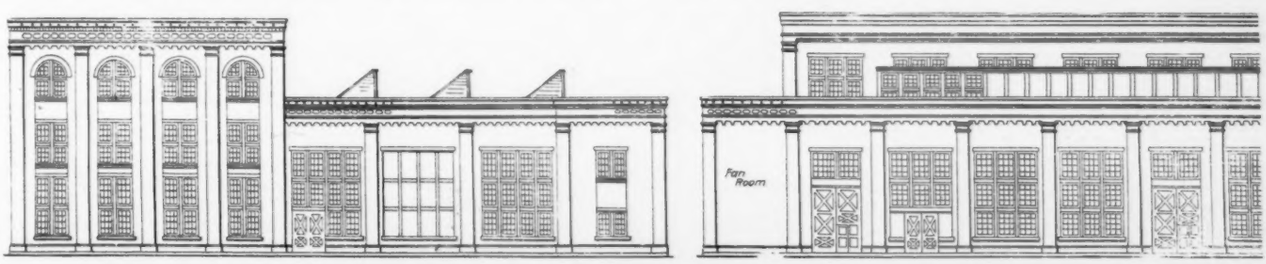
Construction was greatly simplified by using columns exactly alike in the longitudinal rows. The columns were in all cases designed to support not only the brickwork and roof, but also the crane runways and without extra complication to provide for the latter. The columns, in this building, however, are in no case filled with concrete inside.

Extra heavy steel was provided for the cranes. The runways for the 120-ton crane in the erecting shop are 5 ft. plate girders, and are located 65 ft. between centers; those for the 10-ton crane are 2½ ft. plate girders, with a 62 ft. span between centers. The runways for the 7½-ton crane in the heavy tool section of the machine shop are 2 ft. plate girders, located with a crane span of 46 ft. 3 in. between centers. For the 120-ton crane a rail weighing 100 lbs. to the yard was used, while for the smaller cranes a 60-lb. rail was used. Particularly heavy construction was used to amply provide for the heavy rolling loads to be imposed by the cranes.

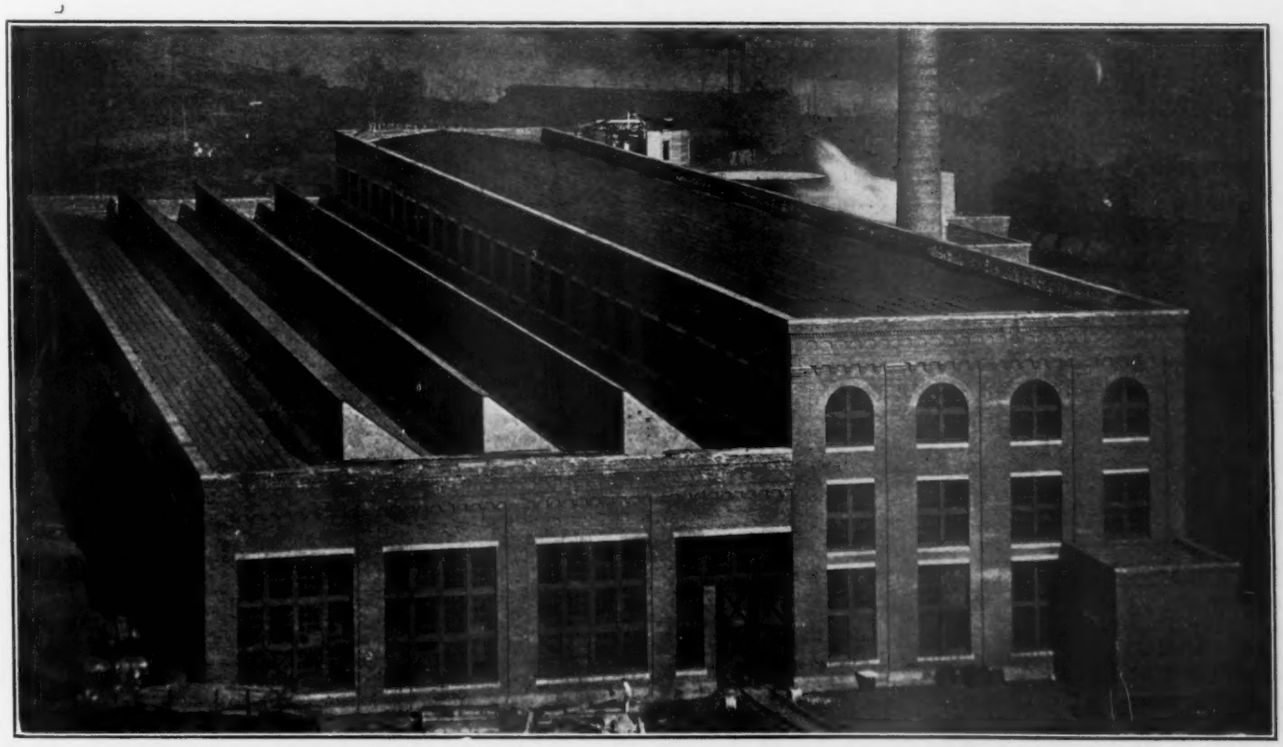
THE FLOOR.

The details of the method of floor construction used are well illustrated in the sectional detail included in the cross-section view. The entire floor of the building has a base of concrete, 4 in. thick. This is covered with five layers of felt, which are laid saturated with asphalt, for waterproofing. The floor stringers are laid above this, bedded in well dried sand, to carry the sub-floor; the sub-floor is of 2¾ in. yellow pine, while the top floor is 1⅛ in. tongued and grooved maple. The concrete used in this floor is composed of American Portland cement, sand and stone in the proportions of one, five and eight.

This construction is one of the most important features of the entire shop, as it has produced a floor capable of carrying machine loads limited only by the crushing strength of the maple of the top floor. As a result most of the machines, that do not require space below the floor surface, are placed on



ELEVATION OF EAST END, AND PARTIAL ELEVATION OF NORTH SIDE, OF THE MACHINE AND ERECTING SHOP BUILDING.



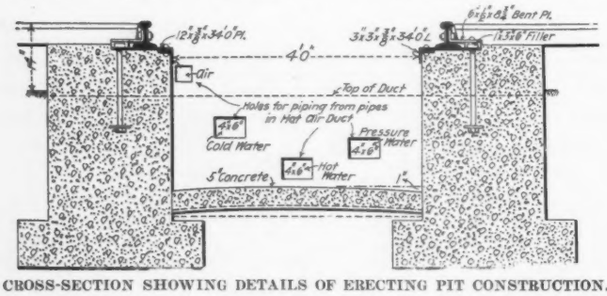
VIEW OF THE MACHINE AND ERECTING SHOP BUILDING FROM THE HILL AT THE WEST SIDE OF THE SHOPS, SHOWING ARRANGEMENT OF SAW TOOTH WIDOWS AND SYMMETRICAL LINES OF CORNICE AND FINISH OF BUILDING.

McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

INTERIOR VIEW IN ERECTING SHOP, SHOWING 120-TON CRANE LIFTING A BOILER, SHOWING ALSO HEAVY CHARACTER OF STEEL CONSTRUCTION.

and attached to the floor without special foundations—thus making it practicable for the arrangement of the machines to be changed at will.

Another important feature of this floor construction is the



CROSS-SECTION SHOWING DETAILS OF ERECTING PIT CONSTRUCTION.

provision of wire boxes, as indicated in the sectional detail. In every third space between the stringers, which run crosswise of the building, the sand filling is withheld and kept out by stops of ⅞ in. board, which are merely nailed against the stringer on each side of the space as shown, and extend from the felt up to the sub-floor. This forms an open channel, or duct, which runs entirely across the building and provides a most excellent method for running power and light wires, in pipe conduits from the main wire tunnel or trench running longitudinally through the shop, to the various tools upon wnich electric motors are used. The arrangement of these wire boxes in the vicinity of the pits is shown in the plan drawing; there are four to each bay and they extend from the north wall across the wire trench to a point opposite the middle of the erecting pits, or up to the erecting pit tracks where they are in the way. The use of these wire boxes will be referred to in another article.

THE ROOF.

The details of the roof steel work are well shown in the cross-section view and also in the detail drawing of the saw-tooth construction, which is used above the machine shop section of the building. In the erecting shop small columns are carried up from the crane columns, ending in large gusset plates, which support the roof trusses and also serve to provide cross bracing. The details of the saw-tooth construction are made clear in the engraving, which shows a cross-section through the saw-tooth windows at the quarter points of the machine shop roof.

The roof consists of a base of 1¾-inch tongued and grooved boards, upon both erecting and machine shop sections, and upon this is laid the roofing felt. The felt is laid heavily saturated in asphalt. Considerable anxiety was experienced in regard to obtaining a suitable roofing material for covering the saw-tooth section of the roof—particularly the trench portion, as it had been thought desirable to make it waterproof for at least one foot above the bottom to take care of snow and water. As one side of this trench is vertical, the conditions will be appreciated as being unusually severe for asphalt roof construction. The roofing material has, however, been put in place, meeting the above conditions, by the Eastern Granite Roofing Company of New York, under an absolute guarantee for ten years.

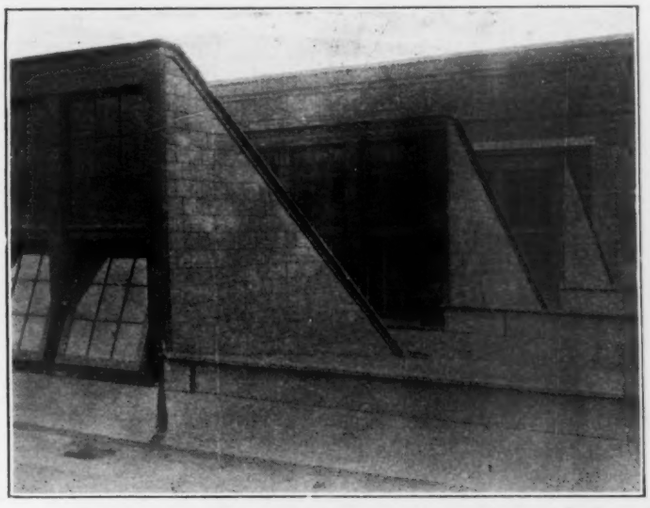
Inside drainage is made use of throughout, to eliminate the possibility of backing up of water due to conductor pipes freezing. The conductor pipes, which are 5 inches in diameter, for the erecting shop section, lead from the flashing boxes to the longitudinal discharge pipes, of which there is one, 8 inches in diameter, carried along under each side of the roof, and supported by the roof steel work, as shown in the cross-section. For the machine shop, 4-inch conductors lead from the flashing boxes to a 5-inch vertical discharge pipe, one of which is arranged alongside of every other column of the middle row, extending through the shop. There are 12 "low," or drainage spots in the roof construction, which amply provide for the drainage.

No direct ventilation is provided in the erecting portion, but the machine shop has excellent provision for ventilation in the saw-tooth windows. These are arranged to be operated in sections, of which there are eight to each saw-tooth, from the

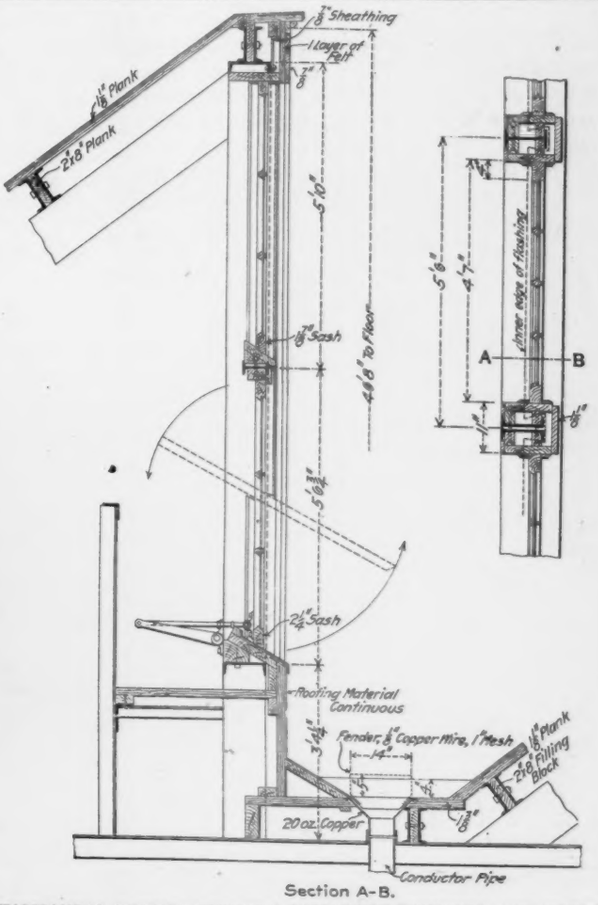
floor of the shop by hand wheels, the mechanism for which is indicated in the saw-tooth sectional detail. Special provision is made for ventilating the water closets, which are located within the shop building, but the details of the latter will appear later in connection with the lavatories and heating system.

GENERAL.

The constructional details of the erecting pits are indicated in a cross-sectional detail drawing. The side walls are of massive concrete construction and are surmounted by a ⅜ by 12 in. plate, 34 ft. long, on each side to provide bearing for the rails. A 3 by 3 by ⅜ in. angle, riveted to the outer edge, protects the outer corner of each concrete side wall, as shown. The plate is anchored to the walls by ¾ by 16 in. anchor bolts, which are spaced 6 ft. 4 in. apart, and the rails



VIEW OF THE MACHINE SHOP ROOF, SHOWING SAW-TOOTH WINDOWS.



HORIZONTAL SECTION THROUGH SAW-TOOTH WINDOWS, AND VERTICAL SECTION, A-B, SHOWING SAW-TOOTH CONSTRUCTION.

INTERIOR VIEW OF THE MACHINE SHOP, SHOWING DAYLIGHT LIGHTING EFFECT FROM THE SAW-TOOTH WINDOWS.
McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

are tied to this plate by special angle fittings, riveted to the plate and raised, so as to easily bolt to the rail.

Each pit is furnished with connections for compressed air, cold water at 80 lbs. and, by a simple patented device, with water at about 200 degrees F. temperature, under a pressure of 100 lbs. per square inch, which latter connection is manifolded with a hydraulic pressure line. The manifold connection makes it possible to fill boilers on the erecting pits with hot water and then test them to any desired pressure up to 300 lbs. per sq. in., and this is accomplished by the use of only one connection with the boiler.

An interesting detail of the shop construction is to be seen

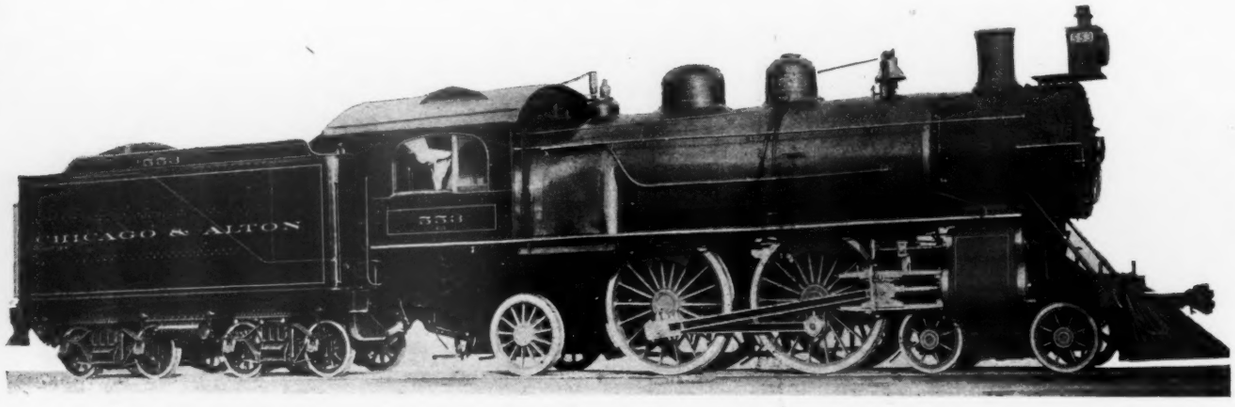
in the details of the partitions used for enclosing the tool room, and the tin shop and air brake repair departments in the machine shop (see the plan drawing). The partitions used consist of woven-wire screen, supported upon angle-iron posts and frame work, the details of which are indicated in the small detail sketch inserted on the plan drawing. The doors leading through these partitions are also of similar construction, making the entire partition work absolutely fireproof, as well as of the most approved sanitary construction.

NEW PASSENGER LOCOMOTIVES.

4-4-2 (ATLANTIC) TYPE.

CHICAGO & ALTON RAILWAY.

The Baldwin Locomotive Works have delivered new passenger locomotives to the Chicago & Alton Railway to be used in the expected heavy passenger service between Chicago and St. Louis in connection with the approaching exposition. These locomotives should admirably supplement the very large 4-6-2 type engines by the same builders, which were described on page 87 of the March number of this journal. The principle characteristics of the new 4-4-2 type are as follows:



HEAVY NEW PASSENGER LOCOMOTIVE—4-4-2 TYPE (ATLANTIC).—CHICAGO & ALTON RAILWAY.

Baldwin Locomotive Works, Builders.

4—4—2 TYPE PASSENGER LOCOMOTIVE, CHICAGO & ALTON RAILWAY.

	Ratios.
Heating surface to cylinder volumes	= 321.9
Tractive weight to heating surface	= 31.9
Tractive weight to tractive effort	= 4.35
Tractive effort × diameter of drivers, to heating surface	= 586.
Heating surface to tractive effort, per cent	= 13.65
Total weight to heating surface	= 56.6

Gauge	4 ft. 8½ ins.
Cylinder	20 x 28 ins.
Valve	Balanced piston
Boiler—Type	Straight; Material, steel
Diameter	70 ins.
Thickness of sheets	⅝ ins.
Working pressure	200 lbs.
Fuel	Soft coal
Firebox—Material	Steel
Length	108⅛ ins.
Width	72¼ ins.
Depth	Front, 71⅜ ins.; back, 57⅞ ins.
Thickness of sheets: Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in. Water space	Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—Material	Iron; wire gauge No. 11
Number and Diameter	326; 2¼ ins.
Length	16 ft.
Heating Surface—Firebox	191.2 sq. ft.
Tubes	3,056 sq. ft.
Total	3,247.2 sq. ft.
Grate area	54.2 sq. ft.
Driving Wheels—Diameter outside	80 ins.
Diameter of center	73 ins.
Journals	10 x 12 ins.
Engine Truck Wheels (Front)—Diameter	36 ins.
Journals	6½ x 12½ ins.
Trailing Wheels—Diameter	48 ins.
Journals	8 x 12 ins.
Wheel Base—Driving	7 ft. 8 ins.
Rigid	15 ft. 8 ins.
Total engine	27 ft.
Total engine and tender	56 ft. 3½ ins.
Weight—On driving wheels	103,690 lbs.
On truck (front)	40,130 lbs.
On trailing wheels	40,000 lbs.
Total engine	183,820 lbs.
Total engine and tender (about)	340,000 lbs.
Tank—Capacity	8,400 gals.
Tender—Wheels—Number	8
Diameter	36 ins.

FOUR-CYLINDER COMPOUND LOCOMOTIVES.

By Alfred G. de Glehn.

This subject is increasing in importance because the 4-cylinder compound stands for an effort to increase the efficiency of locomotives. This journal is indebted to *The Engineer*, London, for this able article by Mr. de Glehn.

So much has been written on compound locomotives in general, and on 4-cylinder compounds in particular, that I fear that the following note on the subject will contain nothing that is new. My only excuse for writing on the matter is that I have been for the last fifteen years in a position to have had exceptional opportunities for watching and helping in the evolution of the type of engine which has been too exclusively associated with my name. It is true that the 4-cylinder compound bearing the Northern of France Company's No. 701, which was the starting point of the type which I should wish to consider in the following note, was designed by me, but in the subsequent development of the engine I wish it to be clearly known that a very large part has been played by the Northern of France Company and the distinguished and liberal-minded engineers who have had charge of the rolling stock, and foremost among these, to mention their present well-known locomotive superintendent, Mons. Du Bousquet.

It is needless to go over old ground and to describe the successive developments of the type, and I will in the following confine myself to a general description of the engine as we are building it now, and to an examination of the reasons that have conduced to its extended use on the Continent. That the system does present marked advantages, in spite of its so-called complication, would seem to be conclusively proved by the fact that 1,500 locomotives of this type are at present either running or building and that their number is extending daily, not only in France, but on the Continent generally.

Whether the engine be a 4, 6, or 8-coupled one, the general principle subsists, namely (1) that the high-pressure cylinders drive one axle, and the low-pressure cylinders another, the coupling rods between these two driving axles having hardly any other function than to maintain the proper relative positions of the crank pins; (2) that for each pair of cylinders there is a complete valve gear as usual, with the usual weigh-shaft; these two weigh-shafts being worked at will, either together or separately by the usual reversing wheel, which sets in motion a screw in two halves, on each of which is a nut connected by a weigh bar with one of the weigh-shafts; (3) that by means of a special valve placed between the high-pressure exhaust and the low-pressure steam chest the high-pressure exhaust can pass directly to the main exhaust, which, with the simultaneous admission of live steam to the low-pressure

cylinders, results in converting the engine for the time into what may be termed two simple engines. The advantages resulting from these arrangements have been often set forth:

Division of stresses.—With the increasing power required for locomotives, it becomes more and more difficult, as every designer knows, to give sufficient wearing surfaces to the different parts for the transverse dimensions of the engine to remain limited, and thus the length of the wearing surfaces is limited also. With the system under consideration there is an outside-cylinder engine and an inside-cylinder engine, each doing about half the total work. For each half of this work there is, therefore, the space usually available in an outside or inside-cylinder engine having to do the whole work. The motion parts can therefore be made very light, and yet with very large wearing surfaces. The two low-pressure cylinders which are inside the frames, save in exceptional cases, drive the crank axle; and, as in normal running, the low-pressure cylinders do somewhat less than half the total work, the crank axle, in so far as its fatigue comes from the steam engine proper, is relieved of more than half that which it has to bear in an ordinary engine. The division of the stress is carried through to the valve gear, and this has been frequently criticised as a needless complication. If we are willing to sacrifice a good deal of economy in steam to more or less apparent simplification, we can, as has been recently done in America, place the four cylinders one by the side of the other and distribute the steam by two piston valves, one on each side, thus having only two valve gears. This arrangement entails, in most cases, either connecting all four cylinders to the crank axle, thus giving it all the work to do, which seems a pity; or inconveniently short inside and inconveniently long outside rods. The cylinder casting becomes extremely complicated. The piston valve if tight is heavy to move, and therefore, fatiguing for the gear; or, if easy to move, is not tight, and, besides, passes alternately high and low-pressure steam—that is, of very different temperatures—and is therefore a source of loss, and, last but not least, till the ideal compressible piston valve be found, entails relief valves on all the four cylinders. The losses by these valves and their rapid wear are but too well known.

Von Borries has lately tried an arrangement in which the four cylinders, each with separate steam chest and valve, are placed one by the side of the other, all four cylinders driving one axle—the crank axle. There are two valve gears, one on each side, actuating the high and low pressure on that side by means of a rocking shaft arrangement giving a varying, but definitely varying, ratio of expansion in these two cylinders. The simplification is more apparent than real, and here again more stress is put on the crank axle and the valve gear than seems advisable with the continually increasing power of modern locomotives.

The only obection that can be made to the four valve gears is the slightly increased first cost of the engine, and this is most certainly compensated by their reduced wear, increased security against breakdowns, and the adaptability they allow to the varying running conditions.

Leaving now this peculiarity of the system, that the division of the total work to be done is carried throughout the engine, not only as far as the axles and propelling gear are concerned, but also to the valve gear, I come to the next point:

Balancing of the revolving and reciprociting parts.—Here, again, this question becomes of more and more importance and difficulty owing to the immense increase in the power of modern engines, and the ensuing great weight of all its parts. In goods engines the comparatively small wheels make the placing of adequate balance weights extremely difficult, and for the very fast running now required from express engines a correct balance becomes more and more indispensable for security, while it is more and more difficult with ordinary engines to keep the variations between maximum and minimum pressures of the wheels on the rails within reasonable bounds.

In the system under discussion the need for using revolving weights for the purpose is done away with. The low-pressure cylinders are, save in exceptional cases, inside the frames. The weights of the reciprocating parts of the low-pressure engine, as it may be called, are greater than the corresponding parts of the high-pressure engine which lie outside the frames; but as the transverse distance between their planes of movement is at the same time less than that between the planes of movement of the outside lying parts, their moments may be made to be very nearly equal, and thus the need for weights to balance the reciprocating parts is done away with. There remains, then, no difficulty in providing for the balancing of the revolving weights, each pair of wheels having its proper balance. It will be seen from the foregoing that in four-coupled express engines on this system the coupling rods are relieved of all stresses, except those necessary to keep the two driving axles in their proper relative position, and to transmit from rear to front axle the slight excess of the work done by the high-pressure over that by the low-pressure cylinders.

In electric motor-driven vehicles the adhesive weight is, as is well known, better utilized than in ordinary two-crank engines, owing to the uniformity of the turning moments. In the engines that I am describing with the four cranks set at 90 deg., the turning moments are, of course, much more uniform than in ordinary engines, and approximate practically very closely to the results obtained by a motor drive. Another advantage of the four cranks is the ease and certainty in starting, and this is further enhanced by the intercepting valve, which enables the driver to work each pair of cylinders with direct exhaust and live steam from the boiler, thus increasing by about 25 per cent. the tractive power of the engine, which can thus start with more certainty, and get up speed more quickly, than an ordinary engine.

I come now to the question of water and fuel economy. Of the economy there is, of course, no doubt; it is its amount concerning which no general assertion can be made owing to the widely varying conditions of locomotive work and the difficulties of getting really proper terms of comparison. It suffices to say that it may be taken as roughly 10 to 12 per cent. all round. This, calculated as money saved per year and per engine, will not appear a large sum, and would most certainly not justify much increase in first cost, in repairs and in liability to break down—in a word, what is generally meant when the word "complication" is used. Nor would it compensate for increased difficulty in starting or unsteadiness in running. But with compounding under this form we get the economy, and an improvement under all the other heads. The truth of this statement will probably be now generally admitted, except, perhaps, as regards the first cost, but it can be proved that per horse-power this type of engine can be made as cheaply, if not more cheaply, than an ordinary engine. One drawback must be mentioned, as I wish to be perfectly fair. There is, in some cases, an increase in oil consumption, this being due to the increased number of parts, each oil hole using a certain quantity of oil usefully and a certain quantity being wasted. The oil used usefully will be proportional to work done, approximately; the waste will not, and this will figure against the system.

It has frequently been said that it is not in the system that the advantages claimed lie, but in the high pressures used. These high pressures most certainly do play a very important part; but it is the system, in a great measure, that has enabled us to use these high pressures without their entailing too much trouble with slide valves, etc., and I may further state that the first four-cylinder compound built in 1885 for the Northern of France had only 157 lb. pressure, and is still as economical in fuel as the later types with pressures of 228 lb.

I have tried to show as plainly and fairly as possible the advantages of the system, and would merely wish to add that it has enabled us to do, on the Continent, work for which in America recourse has been had to enormously heavier engines. What economy would result as regards permanent-ways, bridges, round houses and plant in general, from using for the same work to be done, properly balanced, divided compound engines as well for goods as for passenger traffic, in the place of imperfectly balanced engines some 20 per cent. heavier and larger, it would be difficult to estimate, but an attempt to do so would show pretty clearly a very good case for the divided balanced compound four-cylinder engine.

MOTOR-DRIVEN MACHINE TOOLS.

INTERESTING APPLICATIONS OF ELECTRIC DRIVING TO MILLING MACHINES.

(*Continued from page* 424.)

In this article are presented further examples of the application of motor-driving to milling machines. Considerable attention has been paid to the subject of equipping milling machines electrically, as particularly adapted to individual driving, on account of the varied classes of machining service usually handled. Much has been learned in this important subject by the equipment of this class of machine tools with motors, and special attention should be given to the following examples:

The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have devoted particular attention to this subject both for their plain and universal and for their well-known vertical type of millers. Supplementary to the photo of their motor-driven universal miller, which was reproduced on page 423 of the preceding article, we show, in Figs. 6, 7 and 8, drawings of motor drive arrangements as applied to their No. 3 plain miller and to their No. 6 vertical millers. These drives are conveniently and neatly arranged and undoubtedly represent the best practice in this line.

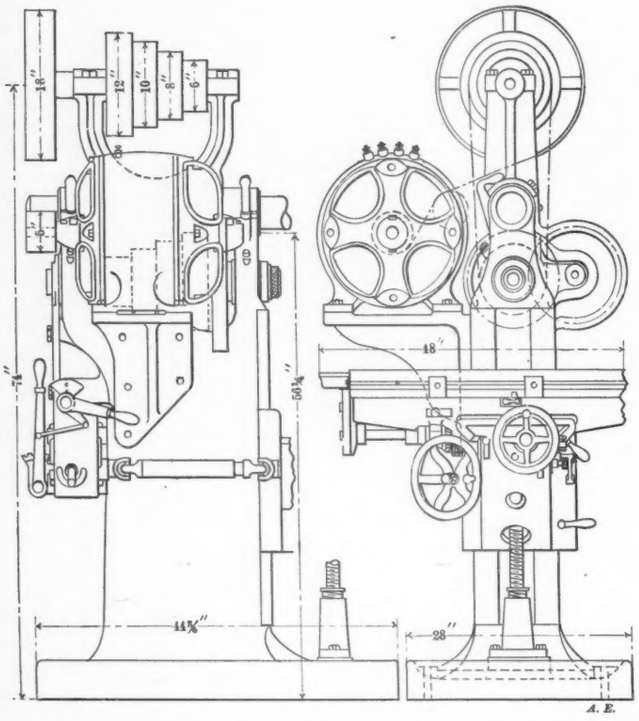


FIG. 6.—SIDE BRACKET DRIVE FOR A PLAIN MILLING MACHINE.

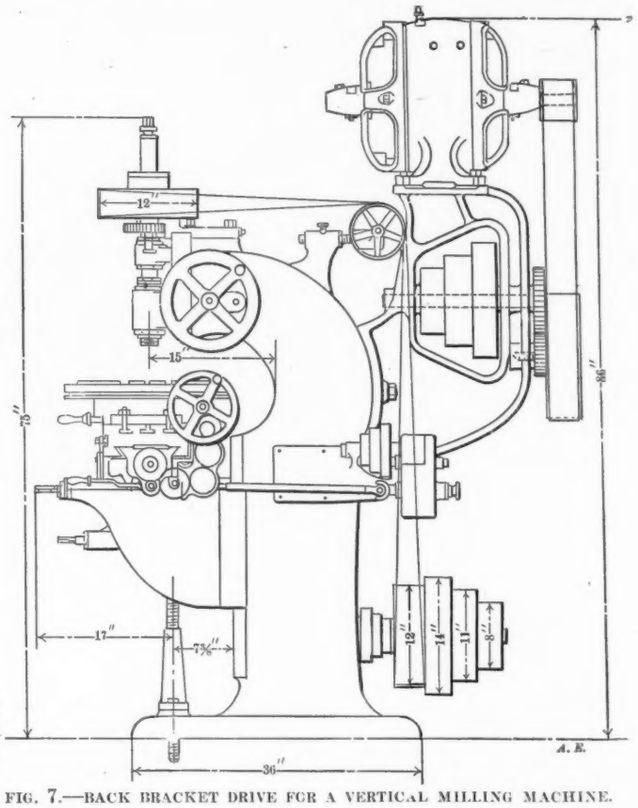


FIG. 7.—BACK BRACKET DRIVE FOR A VERTICAL MILLING MACHINE.

MOTOR-DRIVEN MILLING MACHINES. BECKER-BRAINARD MILLING MACHINE COMPANY.

Fig. 6 illustrates the arrangement used by the Becker-Brainard Company in equipping their No. 3 new model plain milling machine for motor driving. The motor is mounted upon a neat, strong cast iron bracket which is bolted to the side of column, and connection is made by belt to a counter-shaft supported by a bracket at the top of the column; From this shaft a belt drive is made to the main spindle using the ordinary four step cone. This style of drive can be used with either a constant-speed or a variable-speed motor. With a constant-speed motor it allows a range of speeds sufficient for ordinary manufacturing purposes, while with a variable-speed motor it provides the much greater range of speeds that is desirable for special work.

The objection has been made to this method of arranging a drive that the bulk of the motor applied at this point will render the machine top-heavy; but the appearance of this application tends to prove the contrary. The effect given by this design is that of a neat and compact design, with little extra space occupied by the motor. An important feature of this method is that a standard machine may be thus equipped without alterations other than that of applying the necessary brackets for the motor and the small countershaft.

Fig. 7 illustrates a method of applying a motor drive to the No. 6 vertical Becker-Brainard milling machine, as arranged for use with a constant-speed motor. The motor is in this case, mounted on a heavy cast-iron bracket, fastened to back of column and securely braced. The driving connection is made to the spindle through belt and gearing, and then a belt and three-step-cone drive, as in the regular machine. This arrangement is found to give a very powerful drive, and it makes a compact equipment. Owing to the massive and solid design of the frame of this tool, no effect of top-heaviness is produced, but rather a most natural result is obtained.

Particular attention should be given to the heavy design of the motor support bracket. It is heavily webbed for stiffness and strength, and vibration is prevented by a rod brace carried from the top over to the top of the tool's frame. The speed reduction from the motor is obtained by gearing at the end of the upper speed cone, as shown in the drawing; a silent chain drive could have been used from the motor direct to the upper cone shaft, with equally good, if not better results.

In Fig. 8, is shown another method of applying a motor drive to the No. 6 Becker-Brainard vertical miller. It is, in this case, arranged for a variable-speed motor, which is mounted on an auxiliary base at the rear of the machine. The speed cones are here eliminated and connection to the main spindle pulley is made direct through back gears and belt from the motor shaft. This arrangement has been found very satisfactory for use where floor space is not so important, and a larger range of speeds is desired than can be supplied with constant-speed motor.

The motor support is a separate base, which is merely tied to the frame of the tool. It carries the back gears as an entirely separate unit from the remainder of the tool and the

motor and gearing are in this arrangement kept far removed from metal cuttings and other dirt from the machine. The very desirable feature of this equipment is also that it can be applied to the standard tool, thus permitting a motor-driven tool to be had at the least possible excess of cost over that of the standard tool and countershaft—this is a most important feature of the individual drive problem.

An interesting arrangement of milling-machine driving is shown in the engravings, Fig. 9 and Fig. 10, which illustrate an induction motor drive upon the 42-inch combined horizontal and vertical spindle milling machine built by the Ingersoll Milling Machine Co., Rockford, Ill. This is a very compact

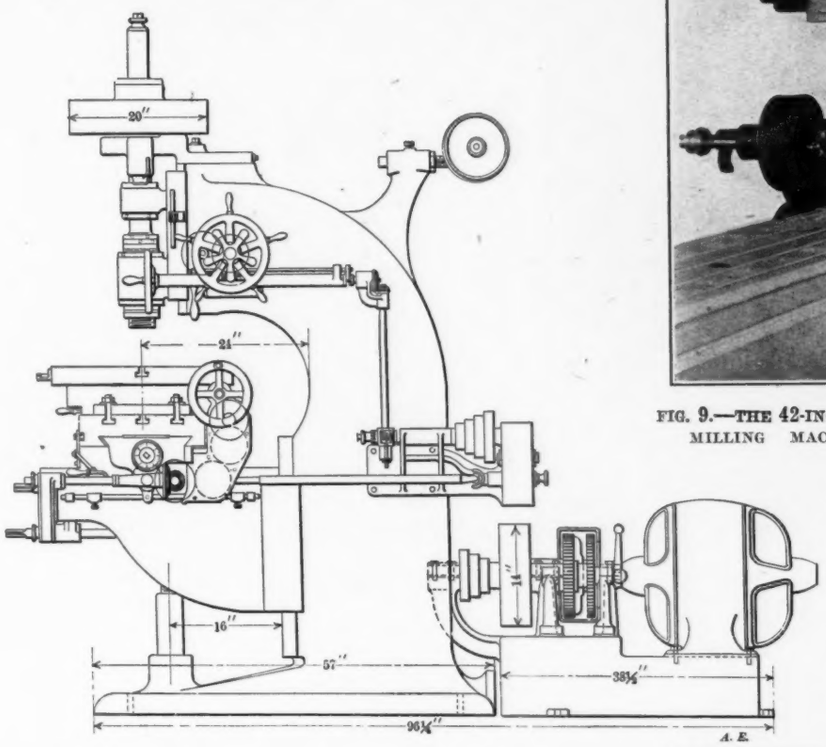


FIG. 8.—FLOOR MOTOR DRIVE AS APPLIED TO A BECKER-BRAINARD VERTICAL MILLING MACHINE.

drive for a tool of this size, the motor being arranged upon a floor plate at one side (see Fig. 10) of, and bolted to the frame, from which position it drives through gearing. A limited range of speeds is furnished by gearing changes at the motor, other changes being of course, provided at the spindle and feeding drives. The motor is of 25 h.p. capacity.

On this particular tool the use of an electric motor has greatly simplified the question of driving; the multiplex nature of the drive is such that great flexibility is necessary, which is possible only with the electrical method of driving.

Supplementary to the description of the Bement, Miles slab milling machine, with a complex drive, presented in the previous article (page 424), we are permitted to here illustrate another similar machine of the same make. This tool, illustrated in Fig. 11, is the No. 6 Bement, Miles & Co. horizontal milling machine, which has a capacity of milling to a size of 31½ x 37½ inches.

It is equipped with their standard arrangement of motor driving in which a gear box is used for obtaining variable speeds. The gear box is clearly shown at the right and in front of the motor, which is a Crocker-Wheeler direct-current constant-speed motor. A wide range of driving speeds are provided by this gear box, thus making a very flexible drive.

One of the latest and neatest schemes for providing milling machines with a contained motor drive is illustrated in Fig. 12. It represents the geared-feed milling machine, built by the Brown & Sharpe Manufacturing Company, corresponding very closely with its No. 1 universal milling machine. Power is supplied by a Crocker-Wheeler semi-inclosed shunt-wound motor and the speed regulation is afforded by a Crocker-Wheeler 12-

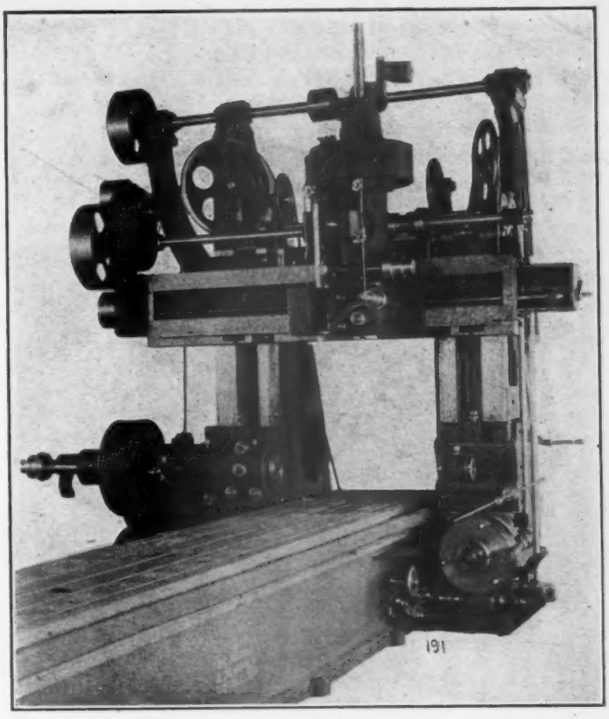


FIG. 9.—THE 42-INCH COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE, MOTOR-DRIVEN.—INGERSOLL MILLING MACHINE CO.

point controller, designed to operate on the 4-wire multiple-voltage system, giving six speeds by voltages ranging from 40 to 240 by increments of 40 volts each and an equal number of intermediate speeds by resistances. In all twelve speeds in either direction are made convenient, and instantaneously available by means of the controller, which is most conveniently located for the operator.

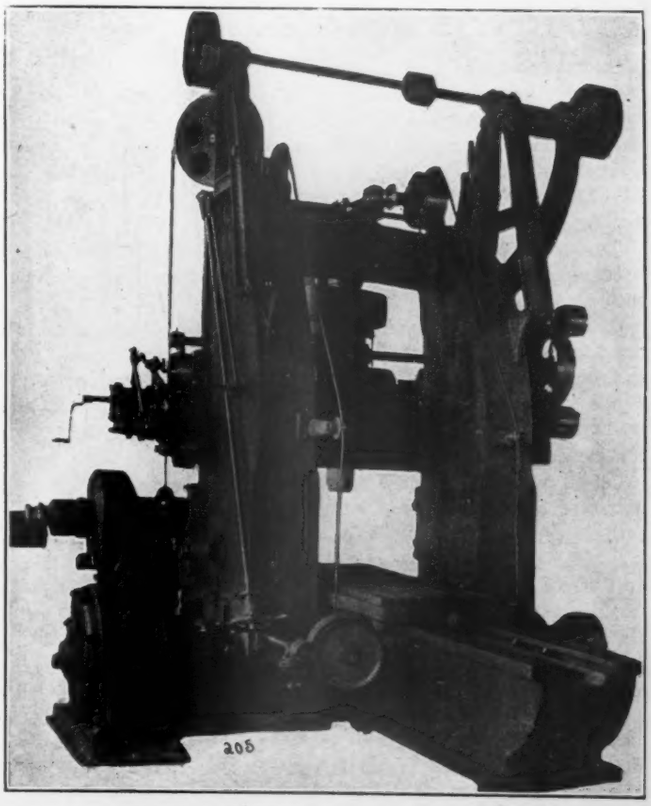


FIG. 10.—REAR VIEW OF THE INGERSOLL MILLING MACHINE, SHOWING ARRANGEMENT OF MOTOR AND DRIVE.

This tool was designed especially for light rapid work, such as the finishing of small brass parts, so that it required a motor of only 3 h.p. The speed reduction from motor to tool is about 3½: 1, the lowest speed of the motor rotating the spindle at 44 rev. per min., and the highest speed at 276. With the extreme limits of the table travel, the machine requires a floor space only 86 ins. wide by 44 ins. in line with the spindle, and an over all height of the motor as located above the machine is but 6 ft. 4 ins., so that the motor is at all times easily accessible for inspection or adjustment.

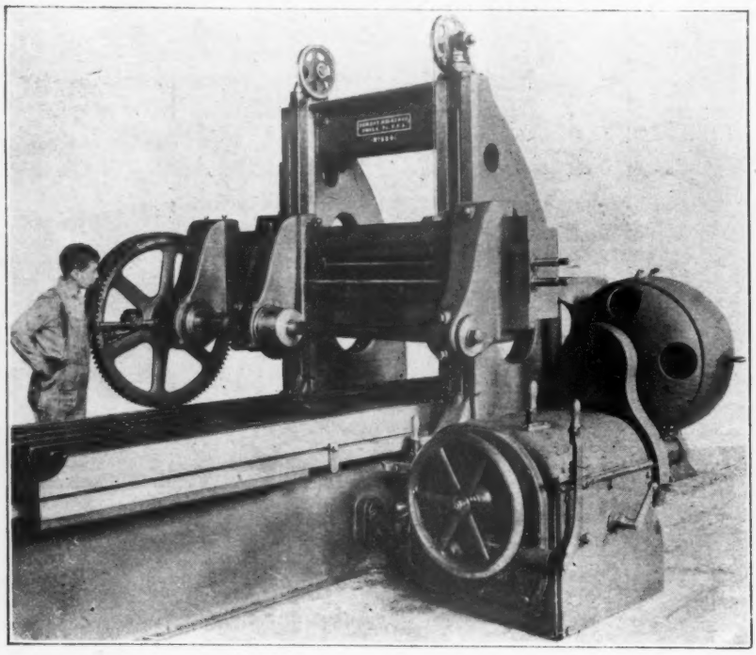


FIG. 11.—VARIABLE-SPEED MOTOR DRIVE, USING GEAR MECHANISM, FOR BEMENT, MILES & CO., SLAB MILLING MACHINE.—CROCKER-WHEELER MOTOR.

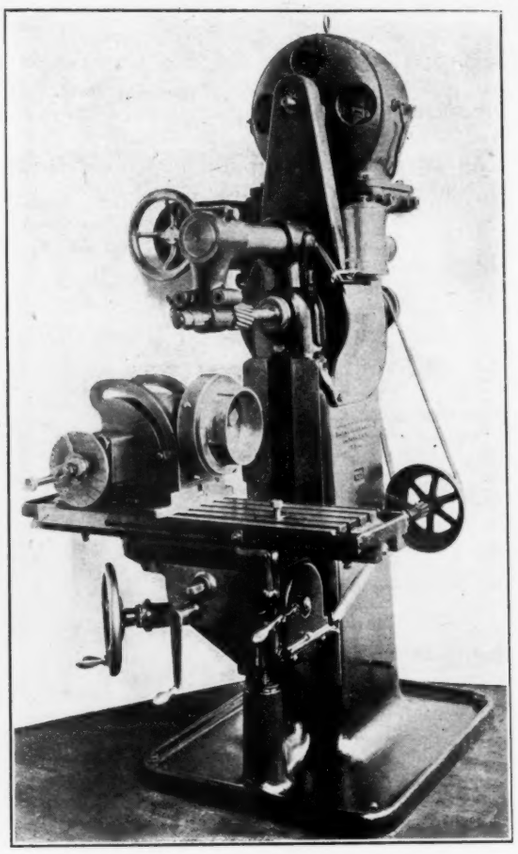


FIG. 12.—VARIABLE-SPEED DRIVE FOR A BROWN & SHARPE UNIVERSAL MILLING MACHINE.—ALL PARTS ENCLOSED.—CROCKER-WHEELER MOTOR.

LIMITS OF WEAR OF CROSSHEAD PINS.

A correspondent writes as follows:

"I would deem it a great favor if you will furnish me with references to articles in the AMERICAN ENGINEER concerning the designing of bearings in locomotive crossheads. What I wish particularly is to establish a limit for wear of crosshead pins of either cast steel or cast iron and used with locomotives having cylinders of different sizes."

This subject has not been treated fully in the way outlined by this correspondent and the reply to his letter may perhaps interest others.

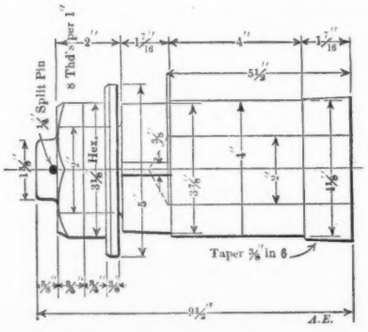
In the case of crosshead pins, which are in double shear, the bearing surface of the brass becomes the limiting factor. Assume a locomotive with 20-in. cylinders, having 314.16 sq. ins. piston area. With 200 lbs. pressure the load on the crosshead pin, from the steam alone, disregarding the effect of water in the cylinders, is 314.16 x 200, or 62,832 lbs.

Let us assume two sizes of pins, the first being 3.75 ins. in diameter and the second 3.5 ins., the length being 3.5 ins. in both cases. The projected area of the 3.75-in. pin is 13.125 sq. ins. The projected area of the 3.5 pin is 12.25 sq. ins. The unit stress in the first case is 62,832 divided by 13.125 or 4,787 lbs, per sq. in. For the smaller pin the unit stress is 62,832 divided by 12.35 or 5,129 lbs. per sq. in.

In this case a pin 3.75 ins. in diameter will be satisfactory for a new engine and an allowance of ¼ in. for wear may be safely made and yet the unit stress be kept within reasonable limits. One of the plants now included in the American Locomotive Company used a unit stress of 4,200 on new pins; another one uses 4,800 lbs. It seems to be good practice to allow these pins to wear until the load becomes about 5,000 lbs. per sq. in.—this is a safe figure.

On main crank pins the load per square inch of projected area should not be greater than from 1,600 to 1,700 lbs., the load being computed for simple engines by multiplying the piston area by the boiler pressure and for compound engines by multiplying the low pressure piston area by the boiler pressure and dividing this product by the cylinder ratio plus 1.

The unit of wear on a crosshead pin is reached first by the ability of the pin to remain in service without getting hot before the matter of structural strength becomes a factor, and if the pins are made sufficiently large to begin with to give



about ¼ in. wear before the unit stress becomes more than 5,000 lbs. per sq. in., the results will be satisfactory.

This engraving illustrates the crosshead pins of a locomotive with 22 x 28-in. cylinders. This pin has a 4 x 4-in. bearing surface with a projected area of 16 sq. ins. At 180 lbs. pressure the total load is 68,423 lbs., or 4,276 lbs. per sq. in. The same crosshead was used on another engine with 22-in. cylinders, having 200 lbs. pressure, which increased the load to 4,750 lbs. Of course these pressures are not constant, as the strain is very much reduced while running at speed with the mean effective pressures reduced.

HYDRAULIC DROP TABLE.

AT SHERIDAN, WYOMING.

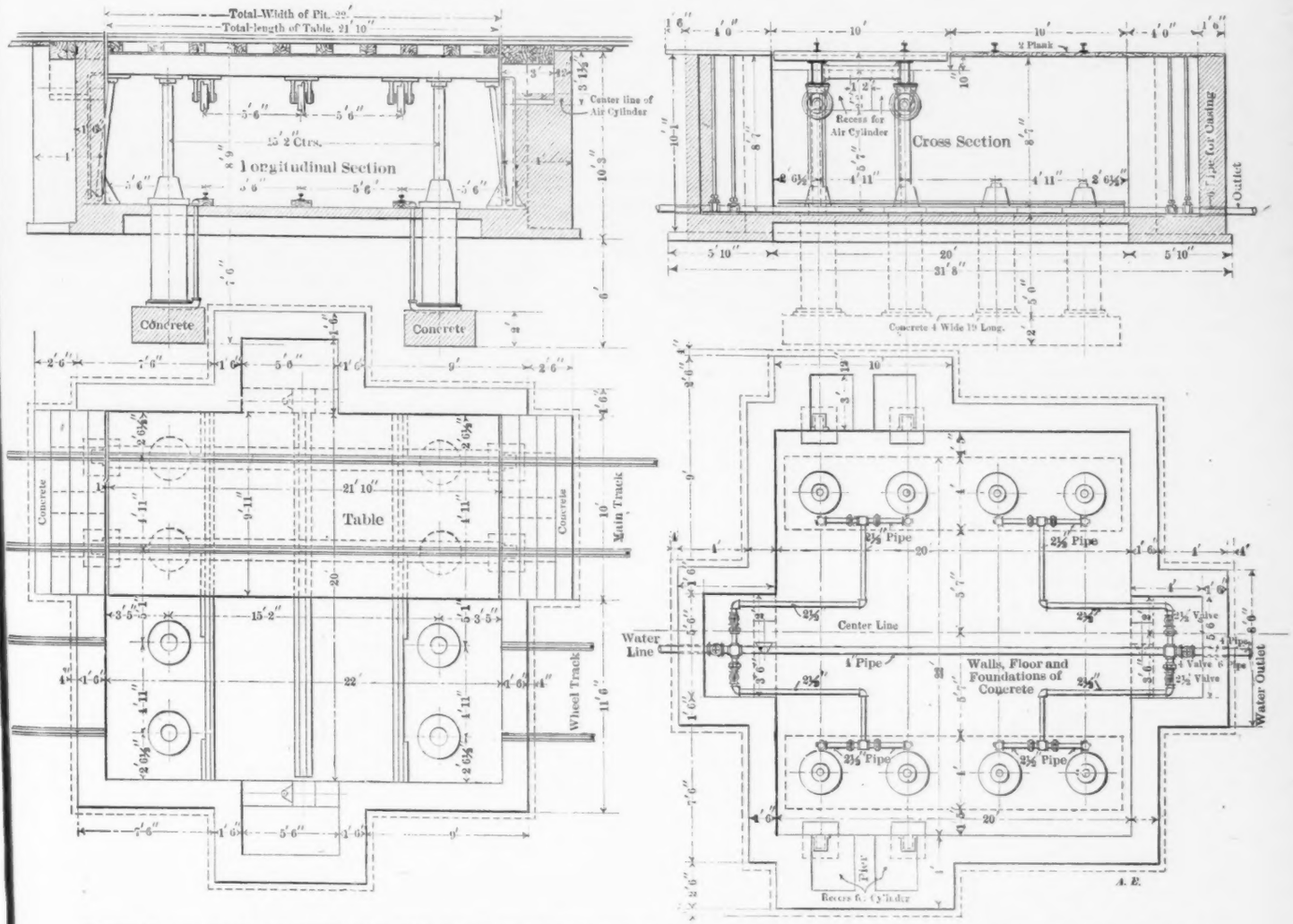
BURLINGTON & MISSOURI RIVER RAILROAD.

At Sheridan, Wyo., a division point of the Burlington & Missouri River Railroad, is installed a very unique and useful hydraulic drop pit and table, which was designed to meet the requirements necessary for handling heavy engines at small repair shops where the plan of shop did not permit the use of traveling cranes.

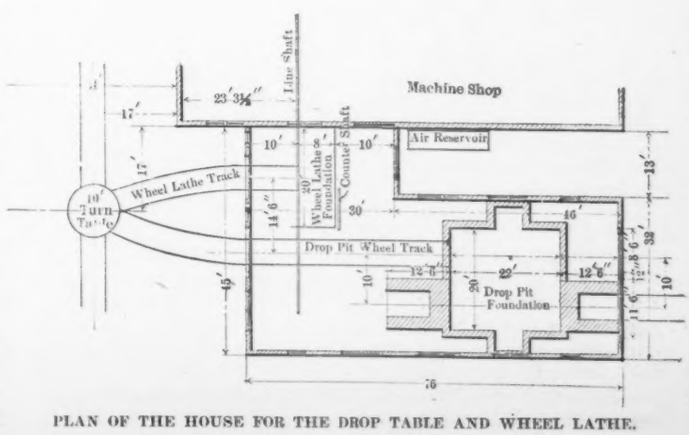
The principal feature of this drop table is that it is possible to drop one pair or all drivers from the lightest or heaviest engine and transfer them from the engine to the wheel lathe with the least amount of labor, the lathe being conveniently located in the same building. On account of the nature of the ground it was found necessary to completely enclose the pit with concrete walls and floor, water having been found at a depth of 5 ft. from the surface. The plant consists of eight cylinders embedded in the ground on concrete foundations, and a transfer table. These cylinders are located as shown in the section views, four cylinders being used on one side to carry the transfer table when the engine passes over, while the four cylinders on the other side are used to elevate the transfer table and load to the level of the wheel track. The longitudinal section of the pit illustrates the transfer table in position for an engine to pass over it.

Hydraulic pressure was preferred for the power for raising the pistons on account of its uniformity, as it was feared that with pneumatic pressure there might be a liability of failure and consequent serious accident or delay. To further prevent possible failure two locks were placed at each end of the transfer table, one under each track, as indicated in the longitudinal section. These locks are pushed into position by a small air cylinder before the engine passes over the table. It will be noticed that the transfer table is provided with track wheels on the under side. These are used for transferring the table from the left hand to the right hand cylinders, and vice versa. A general plan of the house is shown in the lower engraving.

The method of operation is as follows: The transfer table is moved into position over the four cylinders at the left hand side of the pit and pressure turned on from the water main. It will be noticed below that each pair of cylinders have



SECTIONS AND PLANS OF HYDRAULIC DROP TABLE FOR DRIVING WHEELS AT SHERIDAN, WYO.—BURLINGTON & MISSOURI RIVER RAILWAY.



PLAN OF THE HOUSE FOR THE DROP TABLE AND WHEEL LATHE.

their own valve. By this means difference in movement of cylinders can be controlled by the operator and the table raised level. As soon as the table is in position the air is turned on to the locking cylinders and the locks put into position. The water pressure can be turned off, if desired, and table will rest on the locks. The engine is now pushed across the table until the truck stands clear and it is possible to put jacks under the rear end. Jacks are then put under in front and rear to steady the engine and take the weight off the table. The water pressure is turned on and the table rises just enough to raise the drivers clear. If the engine is to be sent to the shop for repairs the wheels are dropped down and the table transferred to the position over the four cylinders at the right hand side of the pit, after which it is raised to the level of the rails and the wheels rolled off to the wheel track. This done, a specially designed truck is rolled on the table and the latter returned to its position under the engine, the truck being then placed under the rear end and engine jacked down. It is then ready to be pushed into the shop.

The hydraulic lifting cylinders are 20 x 60 ins. of cast iron, and the piston rods are 7½ ins. in diameter. The transfer table is 21 ft. 10 ins. long and is built up of 15-in. I-beams with diagonal bracing of angles. The rails are carried on 6 x 10-in. ties. A more carefully designed drop table equipment is seldom seen.

Mr. R. D. Smith, superintendent motive power, states that the heaviest locomotive thus far handled on this pit is of the 2-8-0 type, weighing 207,000 lbs. Forty minutes are required for removing the drivers of this engine when it is on the pit and stripped for the purpose. This includes blocking the engine, dropping the wheels, transferring, raising and rolling them off to the wheel tracks. The best record made is 20 minutes for dropping and placing a pair in the lathe ready for turning.

This table has saved quite an amount in labor when handling heavy wide firebox engines, and does away with the necessity of jacking up the engines as high and using as much blocking as would be necessary if all drivers had to be removed. The operation for one pair of drivers, of course, is quite simple, as the engine stands on the table until the drivers are replaced. The plans were prepared by Mr. E. W. Fitt, chief draughtsman of the road, and the plant was installed under the supervision of Mr. C. J. Saberhagen, division master mechanic at Sheridan.

THE CONVENTIONS FOR 1904.

The next annual convention of the Master Car Builders Association will be again held at Saratoga Springs, N. Y., June 22nd to 24th, 1904, inclusive, with headquarters at the Grand Union Hotel. The American Railway Master Mechanics Association will also hold their next annual convention at Saratoga Springs, June 27th to 29th, inclusive, with their headquarters also at the Grand Union Hotel. Applications for hotel accommodations should be made to Woolley & Gerrans, care of Hotel Marie Antoinette, 67th street and Broadway, New York City, up to May 1st, but after that date, to Woolley & Gerrans, Grand Union Hotel, Saratoga Springs, N. Y. Applications for exhibition space should be addressed to Mr. J. Alexander Brown, secretary, 24 Park Place, Room 17, New York City.

WANTED

By a mechanical engineer, age 29, with 5½ years' shop experience up to position of superintendent of locomotive repair shop, with 120 men, and 6 years' drawing office experience up to chief draftsman, designing large railroad shops.—A position in either of the above capacities or similar work. Address Confidential. Care Editor of this journal.

WANTED.

A mechanical engineer with shop training, member A. E. M. M. A., who is thoroughly up in locomotive and car design, desires a position with a responsible concern. Would consider communication from a supply house requiring the services of a man whose engineering experience would make his services of value in questions involving the strength of materials as applied to design of locomotive and car specialties. References given. Address Y., care AMERICAN ENGINEER, New York City.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XI.

BY C. W. OBERT.

The Lodge & Shipley Machine Tool Co., of Cincinnati, O., have for some time past been applying to the various sizes of their line of lathes, a geared variable-speed feeding mechanism, which embraces the latest ideas of design in the line of variable-speed machinery. It is of interest particularly for the large number of speeds which it makes available at the lead screw for screw cutting and feeding; the various screw-cutting speeds are designed especially to produce the most desirable screw threads with exactness for each position of the handles, making the lathe most easy to handle. The mechanism is of a very compact design and is carefully located for protection to all working parts.

The details of the design, which the variable-speed mechanism used embodies, is made clear in the engraving, Fig. 51, and is shown as it appears, applied to the lathe in Fig. 52. The view of the headstock end of the lathe bed, Fig. 53, which is a plan

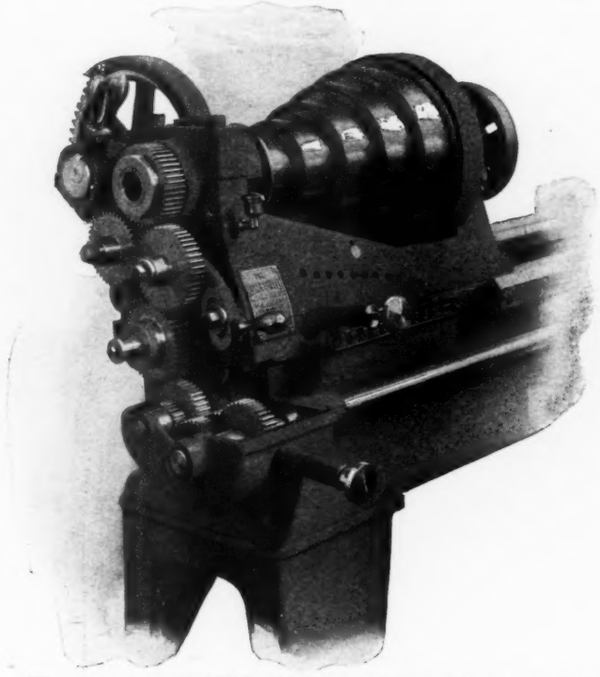


FIG. 52—VIEW OF THE HEADSTOCK END OF THE LODGE & SHIPLEY LATHE, SHOWING ARRANGEMENT OF THE VARIABLE-SPEED FEEDING MECHANISMS.

view, looking vertically downward upon the bed with the headstock removed, is of assistance in indicating the relative proportions of the mechanism.

This variable-speed mechanism is arranged in two parts as is indicated in Fig. 52. One is located beneath and within the headstock and has a capacity of eleven speeds, while the other, a four-speed device, is located at the end of the bed, outside, where connection is made with the lead screw. The portion within the headstock has direct connection with the lathe spindle, through gearing as shown at the end, so that it acts as the driving mechanism. This gearing is also capable of being changed so that extra ranges of speed changes may be obtained at the lead screw of the lathe, if needed.

The driving portion of the mechanism, which is located within the headstock, has a capacity of eleven different speeds, as applied to their lathes up to the 20-inch size. The speed changes are obtained by the cone of gears and shifting pinion principle; this is clearly shown in Figs. 51 and 53, in which the arrangement of the gear cone, as well as the tumbler, or rocker arm, carrying the shifting pinion, is made clear. The shaft to which the gears of the cone are keyed, extends through the

end of the bed and serves to deliver the drive to the outside portion of the mechanism.

The splined shaft upon which the shifting pinion tumbler slides is the driving member, as it is geared direct to the lathe spindle. The tumbler carries a sleeve surrounding and feathering with the splined shaft; upon one end of the sleeve is mounted a pinion, meshing with and serving to transmit motion to the shifting pinion at the end of the tumbler arm, which comes into contact with the gears of the cones. The sleeve has an ample area of key contact with the splined shaft, and has also a long bearing thereon for accuracy and stability.

The shifting pinion is dropped into mesh with any gear of the cone by merely lifting the knob on the other leg of the tumbler and bringing it to a locking position, as it is to be seen in Fig. 53. This opposite leg of the rocker is shaped to project out through the slot in the bed and up in front of the headstock, as shown:

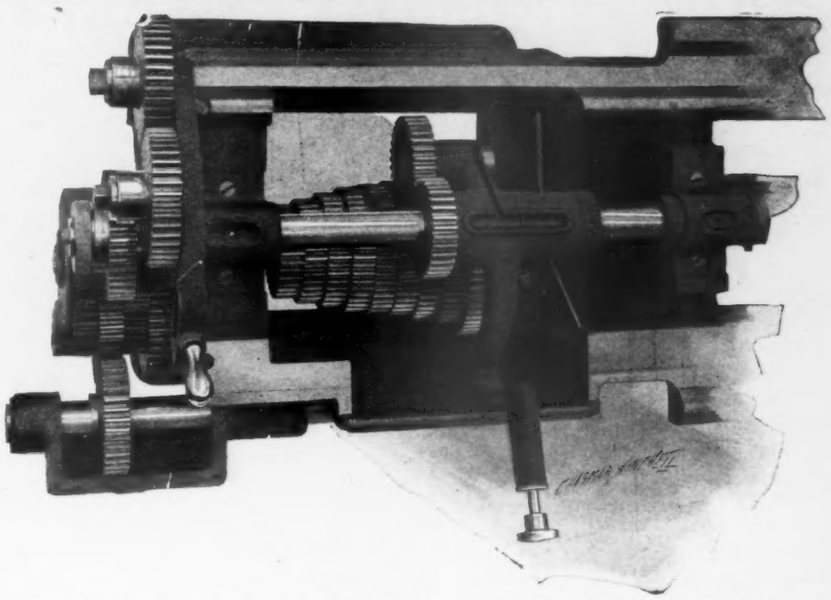


FIG. 53.—VIEW OF THE MECHANISM BENEATH THE HEADSTOCK, TAKEN LOOKING VERTICALLY DOWNWARD UPON THE LATHE BED.

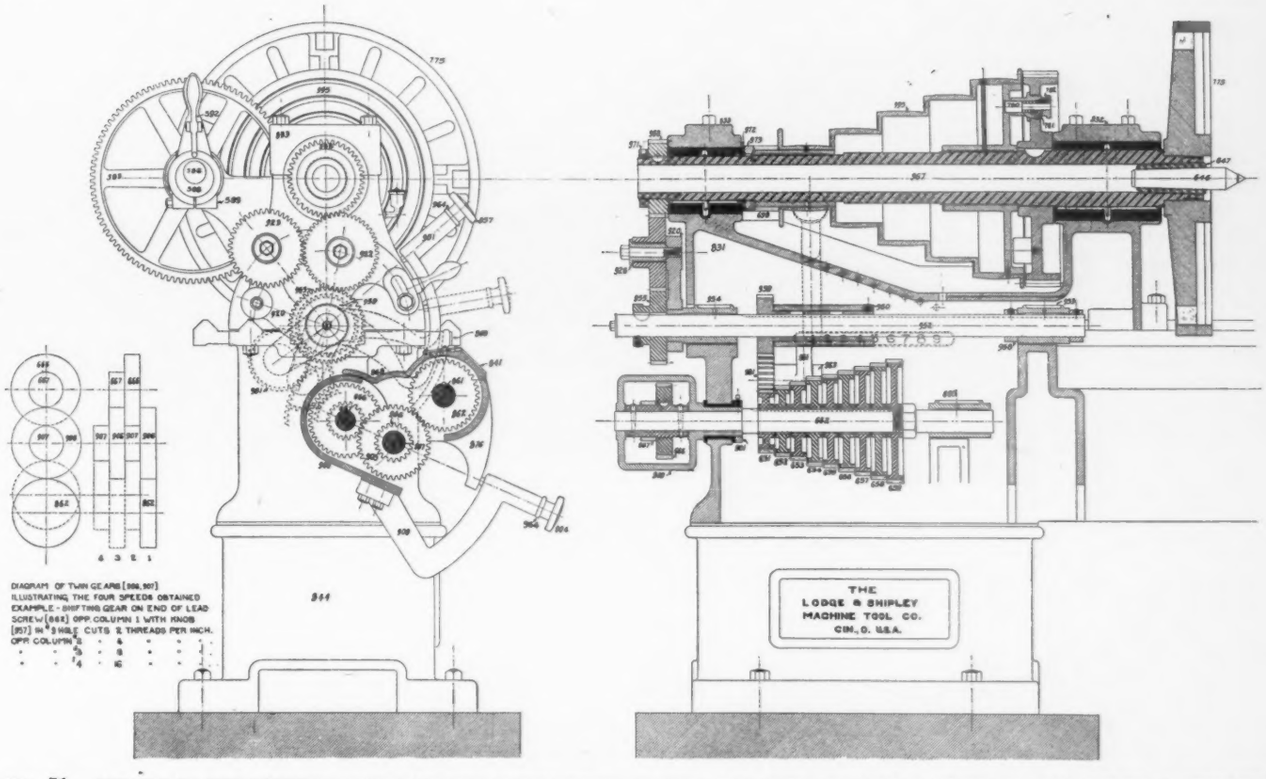


FIG. 51.—DETAILS OF THE POSITIVE GEARED FEEDING MECHANISMS WHICH ARE USED ON THE LATHES OF THE LODGE & SHIPLEY MACHINE TOOL COMPANY.

When properly in mesh with a gear of the cone the spring pin of the knob will lock into one of the numbered locking holes on the front side of the headstock; in changing speed it is merely necessary to shift the pinion by moving the knob along, when in its lowest position, until in line with the numbered hole desired, and then raise the knob until the locking pin springs into place.

The principle of the four-speed box, outside is also made clear in the accompanying engravings, although particularly so in the end elevation view in Fig. 51. The same general principle governs the operation of this mechanism as the other. Here four gears arranged upon a tumbler, or rocker arm, are driven at different speeds, and may be brought up into mesh, any one in turn, with a gear on the lead screw shaft. A similar method of locating and locking the tumbler knob is used, which provides great facility in operating the two devices.

The operation of the two mechanisms in combination for the entire range of screw threads, provided for is made easy by the use of a simple index plate, which shows in what positions to locate the knobs of the two mechanisms for obtaining them. The construction is simple, so that there is little liability of trouble and inaccuracies. The design is altogether commendable and tends toward serviceability.

A TEST OF FIREPROOF PAINT.

On October 17, 1903, the National Fire-Proof Paint Company completed another "public fire test" in the city of St. Louis with gratifying results. Two buildings were erected of the same material, 1-in. Georgia pine, and were erected

September 3, 1903, being 12 ft. high by 6 ft. square, and situated at the corner of LaClede and Vandevonter avenues.

One of the buildings was painted with two coats of the National Fire Proof Paint and the other one with a high grade brand of paint, purchased on the market in St. Louis. The test was made by placing a large quantity of combustible material, composed of hay and wood (over which was poured a quantity of kerosene) between the two buildings, which were situated with 5 ft. of space between.

An exceedingly high wind prevailed, and after starting the fire at 4 o'clock, it was at once noticed that the buildings painted with Fire Proof Paint was at a great disadvantage, as the wind forced the fire away from the other building and against the one painted with this paint, making the test an unusually severe one.

The fire soon became so intense that, notwithstanding the strong wind, both buildings received a baptism of fire, and the effect became noticed in less than ten minutes after the match was applied. Owing to the great mass of the fire being blown against the fire-proof painted building, and being retarded in its efforts to destroy the wood on which the fire-proof paint was applied, it became necessary to replenish with more fuel several times, thus taking a much longer period of time to complete the test than it would otherwise have done. Seventy-one minutes after the fire was started it caused the destruction of the building painted with standard paint so that it fell over against the fire-proof painted building, which remained standing, with but one side and one end severely charred, where the fire had come in direct contact with the woodwork. A close examination, however, showed conclusively that the fire had not spread in any manner whatsoever where it had not come in direct application with the woodwork of the fire-proof painted building, bearing out the claims made by the company.

There were present World's Fair and underwriter officials who conceded in the stand taken by the company as to their claims. The test was made with the permission of the city officials; the buildings standing forty-four days after application of the paint, being a much shorter time than that required to be thoroughly effective in retarding successfully the spread of fire on woodwork.

NATIONAL MACHINE TOOL BUILDER'S CONVENTION.

The third annual convention of the National Tool Builder's Association was held at the Hoffman House, in New York, on November 9th and 10th, with a full attendance. Of the several papers read was one by Mr. Lodge, of the Lodge & Shipley Machine Tool Co., Cincinnati, O., on "The Future of the Machine Tool Industry in the United States." Mr. W. P. Davis of the W. P. Davis Machine Company, Rochester, N. Y., read a paper on "How Can We Improve Trade?" Mr. Lodge spoke in his paper of the state of uncertainty as to the possible limit to be attained in high-speed tool service through the application of electric drives. He believes that two distinct classes of machines will in the future be called for, both with individual motor drives, one being for the machining of cast iron and the other for steel stock. At the second day's session Mr. Joseph Flather, President of the Association, read a paper upon the subject, "What Shall We Do On a Declining Market?" He expressed the opinion that there is no necessity of building machinery at a loss, and that manufacturers of special grades of tools should now take the opportunity to improve their works and their product. An important feature of the convention was the unanimous agreement to maintain the present existing prices; the recent decline in the price of pig iron was shown to be insignificant in its effect upon the finished product. For next year the following officers were elected: President, William Lodge, Cincinnati, O.; first vice-president, W. P. Davis, Rochester, N. Y.; second vice-president, F. E. Reed of the F. E. Reed Company, Worcester, Mass.; treasurer, Enoch Earle of P. Blaisdell & Co., Worcester, Mass.; secretary, P. E. Montanus of Springfield Machine Tool Company, Springfield, O. The next convention will be held at Cincinnati at a date to be announced.

A NEW STEAM TURBINE POWER PLANT.

New Railroad Shops at Aguas Calientes.

MEXICAN CENTRAL RAILWAY.

An extensive and important application of the electrical system of power distribution is one of the most prominent features of the new shops of the Mexican Central Railway Company, Ltd., which are just being completed at Aguas Calientes, State of Aguas, Mexico. It is probable that no installation can be found in the Republic of Mexico which involves more modern applications of electrical and mechanical engineering, and the details of this installation will be of interest, particularly in view of the location of the plant, as well as the local governing conditions at that point in what is ordinarily considered as an uncivilized country.

The plant is the consolidation of, and is intended to replace, a number of smaller shops which were scattered along the lines of the system, the idea being to secure far better facilities and greater capacity and economy by concentrating the various shops in one, and at the same time to make a most complete and modern plant capable of handling all characters of railway repair and construction work, particularly in view of the remoteness of the large manufacturing and supply centers. A large installation was decided upon, including 20 new buildings and new equipment throughout, covering a tract of ground three-quarters of a mile long, and embracing 120 acres.

EXTERIOR VIEW OF POWER HOUSE, SHOWING CHARACTER OF CONCRETE BUILDING CONSTRUCTION.

The site, Aguas Calientes, was decided upon on account of being an important division point of the road; it is located 860 miles south of the El Paso, Tex., terminal and 585 miles north of the City of Mexico. The new shop plant also includes a large and complete tie treating plant, on the plan of the most modern timber preserving principles, for chemical treatment, to withstand the severe climatic conditions in the far South, of all ties to be used upon the system.

In the design of this plant, special consideration was given to the adaptability, simplicity and economy of the various parts. The location of the plant being remote from the shops and manufacturers of the various apparatus, the feature of necessary repairs was worthy of important consideration, and every part of the complete plant was thoroughly considered and carefully planned.

The use of individual power plants located in the various buildings was not considered, as from the standpoint of even the coal consumption alone, the increased economy of one central station over a number of smaller plants prohibited the division of the power plant. The electrical system of power transmission was the only one that could be used, and it was merely a matter of determining the best system suitable for the purpose.

The main yard being approximately three-quarters of a mile in length, with a smaller yard beyond, the transmission of power was a question of considerable importance. The use of a multi-phase alternating current system naturally suggested

itself, but for various reasons, it seemed inadvisable to install such a system; primarily because of the fact that it was desirable to operate certain apparatus with variable speed motors, particularly a number of large cranes, and for this service direct current is far superior to alternating current.

The extended area covered by the various buildings made it uneconomical to carry 250 volts, which is commonly used for power work in installations covering a smaller area, and it was finally determined to operate on the three wire system using 500 volts and 250 volts, thus securing the economy of 500 volts in transmission with the advantages of 250 volts for lighting and other purposes, the two voltages affording a simple and effective means of varying the speed of certain motors for use on wheel lathes and other machine tools.

The high price of fuel at this point made it of vital importance that the power generating equipment should be of the highest economy, and it was also necessary that it should be installed conformative with the most modern practice, as the consideration of the hardiness of the various parts of the apparatus and its ability to give continual service without the necessity of repairs was of equal, if not greater, importance in the power plant than in the balance of the installation. Steam turbine generators were considered to be best suited to meet these requirements because of their simplicity and freedom from liability to break down, combined with their high economy of operation, and a thorough investigation of the subject led to the adoption of the De Laval combined steam turbine generator, built by the De Laval Steam Turbine Company.

It was decided to use water tube boilers designed to deliver 200 lbs. steam pressure with 100 to 120 degrees superheat, as the high pressure and the use of the superheat, will serve to increase the economy of the plant. Three Babcock & Wilcox water tube boilers are installed in the boiler house two in a battery and one in a half battery, each boiler being rated at 250 h.p., and capable of delivering 200 lbs. pressure with 120° superheat. Mechanical draft is used, being furnished by two Sturtevant fans, and a low stack is used, as shown in the external view of the power house.

In the generating room, three 300-h.p. De Laval steam turbines are installed, each direct-connected to 200-kw. double dynamos. The turbines are designed to operate condensing with 28 in. vacuum under the above-mentioned steam pressure. A general view of the arrangement of the turbines in the generating room is shown in an accompanying engraving. The most noticeable feature of the plant is the extreme compactness of arrangement of equipment, the entire turbo-generator equipment of 900-h.p. capacity, occupying no more space than a single 500-h.p. horizontal Corliss engine would.

The condenser is of the surface type; it is equipped with an automatic hot well pump, as well as a separate rotative dry vacuum pump, and a cooling tower is used to cool the circulating water. When operating at full load, a vacuum within 3 in. of the barometer is secured with a corresponding higher vacuum at higher loads.

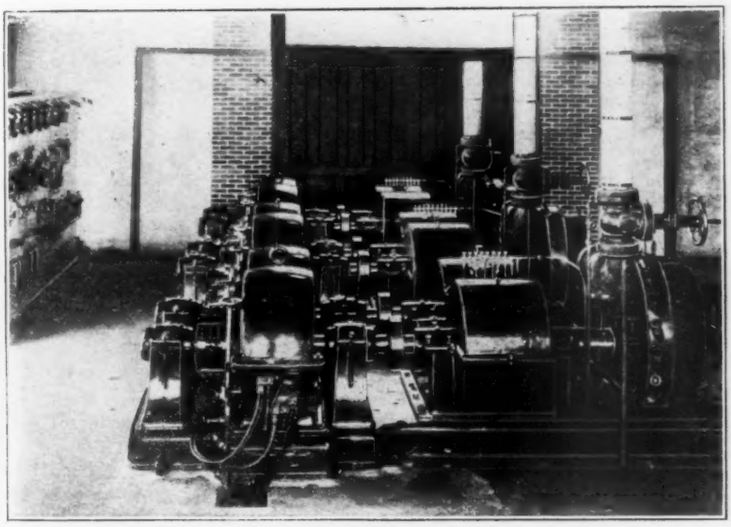
Two steam driven air compressors complete the equipment of the plant for furnishing compressed air for operating the pneumatic tools and for the various other uses. The generating room is covered by a 10-ton traveling hand crane. All steam, water and air pipes and electrical conductors are placed in specially conducted ducts in the floor, covered with cast iron plates. The condenser pit is bridged with the necessary passage, which is flush with the floor.

The dynamos are of the well known De Laval double-armature type, direct-connected to the reduction gears of their turbines. They are wound for two voltages, 250 and 500 volts, the distribution system used being the 3-wire system. The switchboard is built up of blue Vermont marble and contains a full equipment of Weston instruments and all necessary switches and circuit breakers, as well as a recording wattmeter which measures the total power generated in the station.

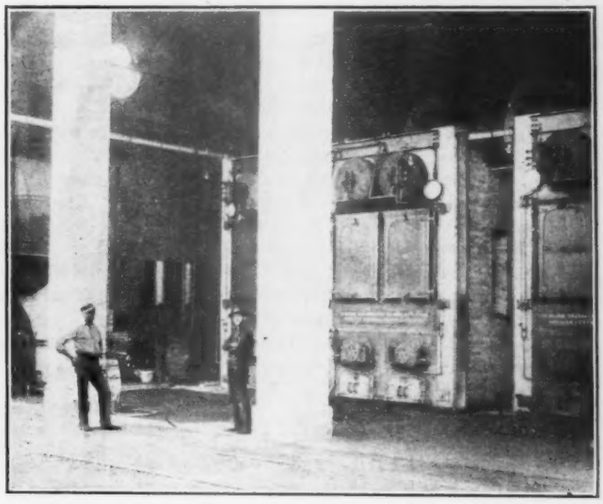
The various shop buildings and stores are thoroughly equipped with elevators and with stationary and portable platform scales and cranes. In the erecting shop, two 60-ton 3-motor cranes travel the main span, while the two bays at each side are equipped with single motor cranes of 5-tons capacity. In order to minimize the stock of wearing and repair parts for motors, the least possible number in horsepower sizes was selected. For this reason, and on account of the fact that a large number of machine tools were to be installed, the group system of drive was generally adopted, although a number of new machine tools have been installed with the most approved method of individual motor driving.

The power is transmitted throughout the yards on overhead lines carried on iron poles in a substantial and thorough manner, all poles being set in concrete and uniformly painted. All mains are carried to the centres of distribution located inside the buildings, where complete equipments of switches and fuses are provided, and the lines leading from the centres to the individual motors are carried in steel conduit, in most instances under the floor. The motors are all protected by circuit breakers for the larger sizes and by suitable fuses for the smaller units.

The entire equipment was installed by the D'Olier Engineering Company, Philadelphia, Pa., sales agents for the De Laval steam turbines, to whom we are much indebted for this interesting information.



VIEW IN GENERATING ROOM, SHOWING ARRANGEMENT OF THE DE LAVAL STEAM TURBINES AND DIRECT-CONNECTED DYNAMOS.



VIEW IN THE BOILER ROOM, SHOWING CONCRETE PIER CONSTRUCTION.—BABCOCK & WILCOX BOILERS.

STEAM TURBINE POWER PLANT.—MEXICAN CENTRAL RAILWAY.

BOOKS AND PAMPHLETS.

Fowler's Mechanical Engineer's Pocket Book, 1904. Edited by William H. Fowler. Published by The Scientific Publishing Company, Manchester, England. Price in leatherette 1 shilling 9 pence, in leather 2 shillings 9 pence.

This pocket book of tables and data is becoming more valuable every year. Not the least important feature is the fact that by annual revision it may be kept up to date and even with the ever-changing requirements for engineering information. In view of the low price of the book the reviewer is disarmed as to most of the criticisms of the work. It is certainly well worth the price, and much more. The complete revision of the treatment of gas engines under the direction of Mr. James Dunlop is one of the special features of this edition.

Proceedings of the Thirty-seventh Annual Convention of the Master Car Builders' Association, held at Saratoga in 1903. Chicago (The Rookery): J. W. Taylor, Secretary.

This year the records of this association require a volume of 620 pages, the largest in its history. Besides the rules, lists of officers and members, the volume contains the papers and reports of the convention of last summer, the discussions thereon, the complete record of standards and recommended practice, and an index. The result of the letter ballot on the changes in the interchange rules is also included. The ability of the secretary of the association is indicated in the appearance of this volume only four months after the close of the convention.

POOR'S MANUAL OF RAILROADS FOR 1903.—The advance sheets of the introduction to the thirty-sixth annual issue of this invaluable publication are before us. They contain the usual statistical summaries of the finacial affairs and operations of the railroads and give comparisons of statistics reaching in some of the tables as early as 1830. The figures of track mileage and rolling equipment are compared for each year from 1880, and in nearly all cases the tables present the figures for the last three years. The total length of railroads completed on December 31, 1902, was 203,131.61 miles, the net increase of mileage reported in the fiscal year 1902 being 3,246.95 miles. Sixteen pages of tables are presented in this summary. This year the volume will contain 180 additional pages, and while the book is somewhat delayed because of being set by machine, advantage has been taken of this fact to include the latest information secured.

Commutator Construction. By Wm. Baxter, Jr. 23 pages, 6 x 9 ins., in pamphlet form. The third of a series of practical papers, each complete in itself. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 25 cents.

The importance of thoroughly understanding the design and construction of commutators for electric dynamos and motors is best appreciated by those who have this class of apparatus to care for; it is safe to say that none can properly care for commutators without understanding their construction. This work will meet a long felt want in placing upon the market a comprehensive and easily understood discussion of this subject, to assist those having charge of dynamos and motors. The treatment is plain and complete, and the illustrations are numerous and clear. An important part is the chapter at the end devoted to repairing commutators, in which detailed instructions and good advice is given.

Up-to-Date Air Brake Catechism. By Robert H. Blackall, Air Brake Instructor and Inspector with Westinghouse Air Brake Company. Eighteenth Edition. Published by Norman W. Henley & Co., 132 Nassau Street, New York, 1903. Price, $2.

The fact that this book has reached eighteen editions since its first appearance, in 1898, speaks for its reception and indicates that it fills a need. It has been completely revised and enlarged. The present edition is accompanied by two large colored charts of the Westinghouse passenger and locomotive equipments. These indicate by the colored portions the various functions of the apparatus, and are well executed. With this book available, no one who desires to understand the air brake need make excuses for not doing so. It is profusely illustrated, and gives evidence at every page of the manner of its development, which is exactly the way one who knows would thoroughly explain the air brake to those who are using it and those who are learning to do so. The explanations are carried even to the operation of trains, and include inspections and tests. The book justifies the title, and is a very valuable work by one who understands his subject so well as to be able to foresee and provide for the difficulties which are before the student. It may be said without the slightest hesitation that one who has mastered this book is thoroughly "up" on air brakes, and that every railroad officer, as well as those who actually use the apparatus, should study it. The price mentioned, $2, includes the charts, the price of the charts alone being $1.

Coal, Cinders and Freight. Book No. 36. Issued by the "Link Belt" Companies. Devoted to Modern Methods applied to the Coaling of Locomotives, Disposing of Cinders, and Handling of Freight in Depots, Warehouses, etc. 96 pages, 9 x 12; cloth, profusely and beautifully illustrated. Published by the Link-Belt Engineering Company, Philadelphia, Pa.

This is a most valuable and interesting treatise of the subjects of mechanical handling of coal, ashes and freight, by the most modern methods, undoubtedly eclipsing all efforts previously made in this line. The illustrations are most excellent and clear, and nearly half of them are full-page photogravures in color. The large number of coal and ash handling plants that these companies have installed upon our leading railroads are carefully illustrated and discussed in a most interesting manner. It is a revelation to observe the methods employed for large plants for stocking and reloading coal, as well as also in power plant installations for handling coal and ashes. Many different systems are illustrated and described for handling all classes of package and bulk freight for depots, warehouses, etc. This is one of the most valuable works of the kind that has been issued and should be in the hands of all who are interested in the subject of mechanical handling of coal, cinders, freight, etc.

GRAPHITE LUBRICANTS is the title of a 20-page pamphlet issued by the Joseph Dixon Crucible Company, of Jersey City, N. J., which is devoted to an explanation of graphite as a lubricant. The chapter entitled "How Graphite Lubricates" is well worth reading.

THE AMERICAN BLOWER COMPANY, of Detroit, have issued five attractive pamphlets, illustrating and describing their apparatus. They are Mechanical Draft Catalog, No. 118, Second Edition; Heating and Ventilating of Manufacturing Establishments, No. 145, Second Edition; Steel Plate Fan Catalog, No. 155 and Circulars, Nos. 39 and 42. Each is complete in itself and collectively, they present an excellent idea of the state of the art as practiced by these manufacturers. Readers who have to do with any of these subjects will do well to secure the pamphlets.

THE AMERICAN TOOL WORKS COMPANY, CINCINNATI, OHIO, have recently issued a neat little reminder, in the form of a small illustrated pamphlet, to call attention to the large assortment of machine tools which they are building. New designs have recently been completed for all the lines of tools manufactured to bring them up-to-date and make them capable of handling the heaviest work that will be imposed by the new heavy duty tool steels. This little pamphlet is well worth examination, presenting, as it does, one of the most complete and excellent lines of machine tools that are built. It will be gladly sent to anyone upon request.

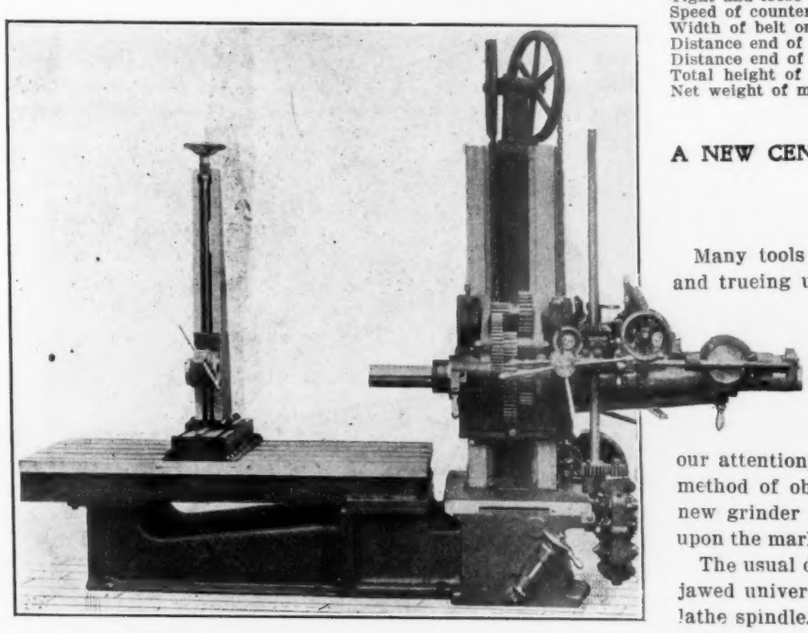
RADIAL EFFICIENCY is the title of an interesting new booklet that Prentice Bros. Company, Worcester, Mass., have recently gotten out, descriptive of the new designs of their radial drilling machines. The Prentice Company have recently entirely redesigned their line of radial drills, improving and strengthening to meet the demands of modern machine shop service, and they have added the very desirable feature of the positive-geared driving mechanism, so essential in drilling work. The efficiency of the new radial is discussed in the booklet in an interesting and convincing manner, and the capacity is a surprise. The Prentice Company indicate also that they have met the demands of the times by arranging their radials for easy application of motor driving—an important feature in modern shop practice. Every shop man should have this pamphlet.

PASSENGER COUPLERS.—A pamphlet has been received from the Washburn Company, Minneapolis, Minn., illustrating and describing the passenger couplers of their manufacture. These makers have a long record behind them and have not rushed into the market with untried devices. These couplers are the result of long study of the requirements of passenger service. Everyone knows the annoyance of delays due to failures of passenger couplers to couple, for example when a flyer is laid out in order to couple to a dining car on a curved siding. To meet this difficulty the flexible head coupler has been developed. It also meets the problem of a satisfactory coupler between tenders and passenger equipment cars with long overhang. This company makes spring buffers and spring coupler carriers in a series of devices, making with the Washburn coupler, a complete coupler equipment for passenger and freight cars. The pamphlet is an excellent example of catalog literature.

A NEW HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

FOSDICK MACHINE TOOL COMPANY.

A new departure in the line of drilling machinery has recently been made by the Fosdick Machine Tool Company, Cincinnati, Ohio, in placing upon the market a new drilling machine of the horizontal type, which is coming into such general use for large numbers of complicated machining operations. The new Fosdick horizontal drill embodies many new features of importance which will render it universally adaptable for operations of boring, drilling, tapping, reaming, facing, milling, etc., on both light and heavy work, in the most economical manner possible, all of the above mentioned operations being possible in one setting of a piece of work fastened to the table, insuring the most accurate and profitable results. The half tone engraving presented herewith was made from a photograph of the machine and shows its well proportioned design.



THE NEW FOSDICK HORIZONTAL DRILLING MACHINE.

The drive for the machine is made through a splined shaft, traversing the driving cone on the rear of bed, and leading to the gearing at the base of the column. The column which carries the spindle head, has a horizontal movement on the bed by hand or power in both directions, and is supplemented by a quick forward and return motion by power, operated by the hand-wheel conveniently located on the front of bed.

The spindle head has a vertical movement on the column by hand or power in both directions, being well counterbalanced and provided with a safety chain, and for quick adjustment is operated through a rack and pinion with ease by the pilot wheel on the front of the spindle head. The spindle runs in adjustable bronze bearings and has a thread cut on its projecting end to receive chucks, large milling cutters, facing heads, etc., for very heavy work. It can be made to revolve in either right or left hand directions by means of a reverse lever; this is very convenient for facing, tapping, milling and other operations.

The spindle bar, which passes through the hollow spindle, is 4 ins. in diameter, has 22 ins. traverse and is fitted with a No. 5 Morse taper to receive drills, taps, reamers, boring bars, milling cutters, etc. It has power and hand feed in both directions, may be operated from the pilot wheel for quick adjustment, and can be securely clamped for face milling purposes. For very heavy work the cutter, or boring bar, is secured by a cotter fitted to the spindle bar.

All the feeds, for horizontal traverse of column, and horizontal and vertical feeds of spindle head, are taken from the spindle; they are positive-geared and reversible, eight in number by hand or power, and are arranged in geometrical progression from .007 to ¼ in. per revolution of the spindle. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 rev. per min. The gear ratio from the cone-driving shaft to spindle is 2 2-3 to 1. and the ratio of back gears is 13.6 to 1.

SPECIFICATIONS.

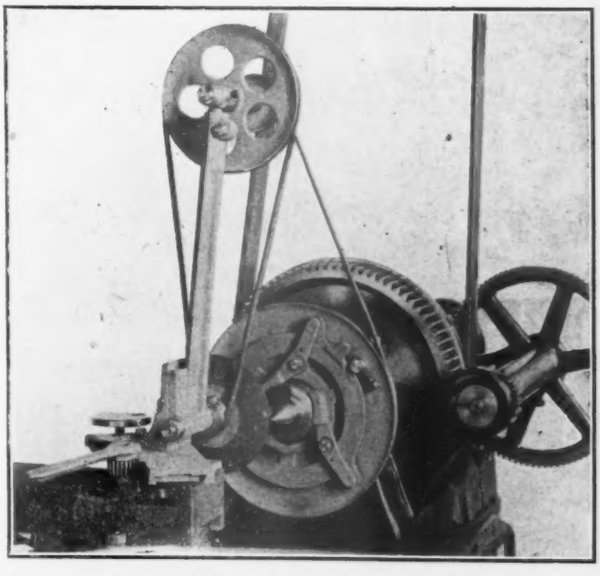
Diameter of spindle bar	4 ins.
Diameter of spindle nose	6 ins.
Traverse of spindle	22 ins.
Vertical adjustment of head on column	36 ins.
Horizontal adjustment of column on bed	32 ins.
Maximum distance table to center of spindle	44 ins.
Minimum distance table to center of spindle	7½ ins.
Size of table	31 x 72 ins.
Tight and loose pulley on countershaft	16 x 4 ins.
Speed of countershaft	228 rev. per min.
Width of belt on cone	3½ ins.
Distance end of pulley shaft to end of bed	9 ft. 9 ins.
Distance end of spindle to end of table	12 ft. 6 ins.
Total height of machine	8 ft.
Net weight of machine	12,000 lbs.

A NEW CENTER GRINDER OF INTERESTING DESIGN.

MUELLER MACHINE TOOL CO.

Many tools have been devised for the purpose of grinding and trueing up centers for lathes, and various degrees of ingenuity have been displayed in their designs. The difficulty has been in the method of driving the grinding wheel in most cases, with the exception, of course, of the more expensive motor-driven types. But no device of this type of a mechanical nature has been brought to our attention, which involves a more ingenious, yet practical, method of obtaining the drive for the emery wheel than the new grinder illustrated herewith, which has just been placed upon the market by the Mueller Machine Tool Co., Cincinnati, O.

The usual difficulties have been avoided by the use of a three-jawed universal chuck pulley for obtaining the drive from the lathe spindle. It is merely clamped over the nose of the lathe spindle, the construction being such that the threads on the nose will not be marred thereby, and revolves with the spindle for driving the grinding mechanism.



NEW DESIGN OF CENTER GRINDER.—MUELLER MACHINE TOOL CO.

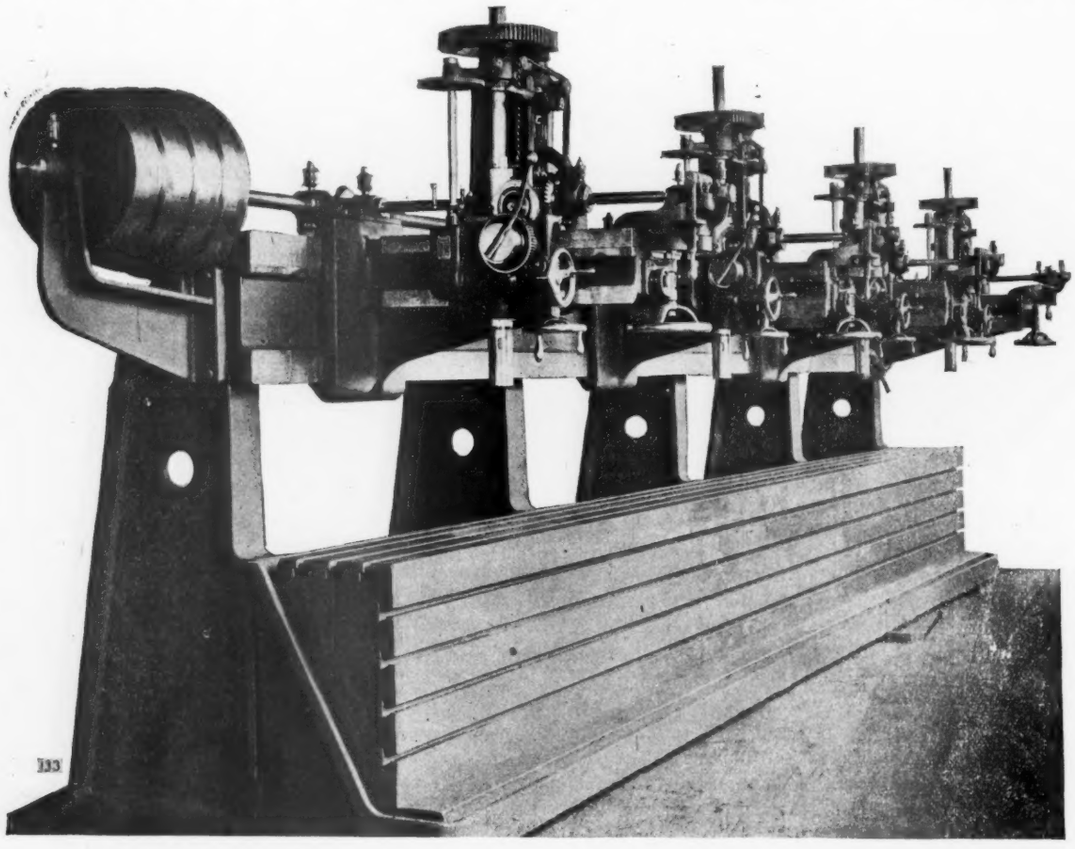
The grinding wheel spindle is carried in a bracket which is arranged to bolt on the lathe tool block as shown in the view of the device. The bracket has a vertical adjustment to permit bringing the grinding spindle to the level of the lathe center, and provision is made for accurately grinding centers to a 60-degree angle by a cross slide adjustment at the base of the bracket, operating at an angle of 30 degrees to the lathe spindle.

The latter cross slide adjustment is clearly shown in the engraving; it is operated by the handle shown carrying a pinion which meshes with a rack cut on the edge of the cross slide.

In mounting the mechanism, it is clamped in the tool block with a shoulder on the bracket base snug against one side of the tool block which brings the cross slide on a line exactly 30 degrees from the lathe spindle center. Then the endless belts are slipped on their pulleys, and the tool is ready for use; this entire operation requires but a few moments.

The spindle that carries the emery wheel is ground taper, having provision for taking up wear, and also has a dust cap for protection from grit. The speed ratio from the chuck-driving pulley to the grinder spindle is such that the grinding wheel will make 1,600 rev. per min., when the lathe spindle speed is 250 rev. per min. An important feature of this tool is the fact that any twisting of belts is rendered entirely unnecessary.

This tool is also applicable to other kinds of light circular grinding by placing a driving drum overhead the latne, for which many uses may be found for it. It also is provided with a small rest, as shown at the left of the emery wheel, which is particularly convenient for sharpening cutters, drills and light work.



FOUR-SPINDLE LOCOMOTIVE FRAME DRILL OF NEW DESIGN.—BICKFORD DRILL AND TOOL COMPANY.

A NEW LOCOMOTIVE FRAME DRILL.

BICKFORD DRILL AND TOOL COMPANY.

The multiple-spindle drill illustrated in the accompanying engraving is an interesting new design of drilling machine that has recently been developed especially for use in drilling locomotive frames. It departs from the usual practice in this class of machinery in several features which tend to facilitate operations upon the tool and add convenience to its manipulation. It was designed and built by The Bickford Drill and Tool Company, Cincinnati, Ohio, from specifications submitted by the Locomotive and Machine Company, Montreal, Canada, and is to be used at the new shops of the latter company for drilling, reaming and tapping the sides and edges of locomotive frames of sizes up to 27 ft. 3 ins. between holes.

The tool is built with four projecting arms, arranged upon a cross rail, of stiff construction and well supported. The arm at the right-hand end is arranged to rotate through an angle of 30 degrees. The arms are made in pipe section, the usual Bickford construction, and are adjustable on the rail either by hand or power.

The spindles have eight changes of speed, ranging in geometrical progression from 49 to 120 revolutions per minute, and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gauge, and hand lever reverse. The back gears are located on the head, bringing the power direct to the work, and may be engaged, disengaged, or thrown out of service while the machine is running, and the operator is not obliged to reach the shifter in order to stop the spindle.

The depth gauge answers a double purpose in this application; besides enabling the operator to read all depths from zero (which does away with the usual delays concomitant to scaling or calipering), it also supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be set in order to disengage the feed at the desired points.

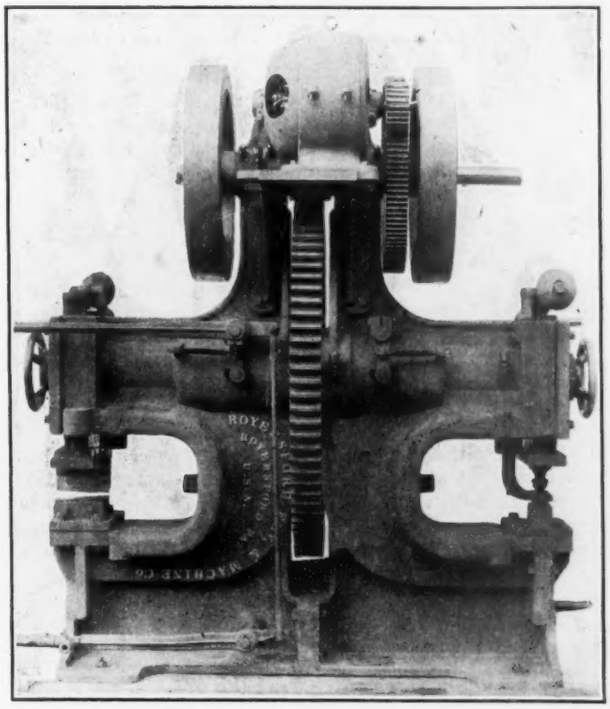
The feeding mechanism furnishes eight rates of feed, ranging in geometrical progression from .007 in. to .064 in. per revolution of spindle, each of which is instantly available, eliminating all loss of time incident to shifting a belt. An engraved plate attached to the head shows the operator how to obtain each of the feeds. The tapping mechanisms are located on the heads, and are fitted with friction clutches operated by levers the handles of which extend around under the arms within convenient reach of the operator.

The spindles are 2⅛ ins. in diameter, have a vertical adjustment of 17 ins., and operate over an area of 2 ft. 4 ins. x 27 ft. 3 ins. The table has a width of 18 ins., a height of 30 ins. and a length of 29 ft. The machine weighes 49,000 lbs., and is designed to be driven by a 5-in. high speed double belt.

A MODERN DESIGN OF ELECTRICALLY DRIVEN COMBINED PUNCH AND SHEAR.

ROYERSFORD FOUNDRY AND MACHINE CO.

The tool illustrated in the accompanying engraving is an interesting application of motor driving to the requirements of modern punching and shearing machinery service. The design of this machine is extremely heavy, and in the effort used



THE ROYERSFORD MOTOR-DRIVEN COMBINED PUNCH AND SHEAR

to bring the construction up to modern requirements, the ordinary standards have been greatly surpassed in this design.

Exceptional fly-wheel capacity has been provided to store up a large surplus of energy between strokes for driving at instants of punching or shearing. It will be noticed that the fly-wheels are located close together, and as the shaft is very short, and also of large diameter, there is little chance for torsion or spring in the shaft. This is an important feature in connection with a punch or shearing machine.

The drive is furnished by a 5 h.p. constant-speed direct-current motor, built by the Crocker-Wheeler Company, Ampere, N. J., which drives the cast steel gear on the fly-wheel shaft through a rawhide pinion on the armature shaft. The gear ratios are such as to bring the proper fly-wheel speed, for which the machine was designed, directly. This style of drive is very convenient and neat, requiring no extra floor space and also keeping the motor up out of the way of harm.

This machine has an 18-in. throat on both sides, and has a shearing capacity of 6 ins. x ¾ in. flat and 1¼ ins. round iron and a punching capacity of 1-in. hole through ⅝-in. iron plate. It will also be noticed that the punch side is provided with a removable lower jaw, which makes it desirable for punching I-beams and channels. This makes an ideal machine for punch and shear work of modern requirements. The eccentric shaft is of steel and of a large diameter, giving ample wearing surface. The eccentric boxes are made of phosphorus bronze.

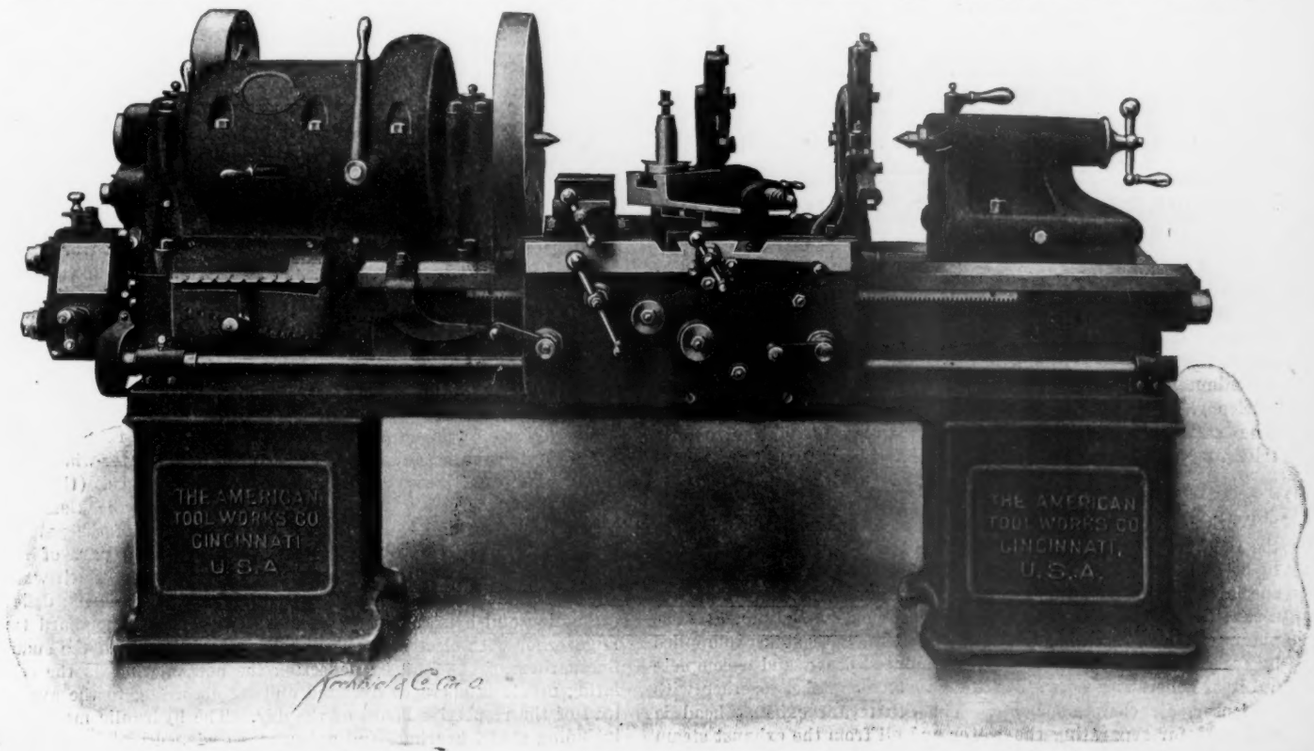
It is built by the Royersford Foundry and Machine Company, of Royersford, Pa., who build a large range of sizes of punch and shearing machines, combined and single end, and for almost all purposes, including railroad shop, locomotive and car building and general machine shop work.

GEARED VARIABLE-SPEED DRIVE FOR THE "AMERICAN" LATHE.

THE AMERICAN TOOL WORKS COMPANY.

In view of the marked tendency in modern shop practice toward all-gear drives for machine tools, the lathe shown in the accompanying illustration will be of special interest to all who are concerned with the use of machine tools. It shows the American lathe, built by The American Tool Works Co., Cincinnati, O., with a new friction all-geared head, designed for direct connection to an electric motor.

The headstock is, in this case, built as a complete unit to which any type of motor, constant or variable-speed, may be readily connected, the motor being set on top, or at the rear of the gear casing. The mechanical speed changing device is simple and powerful, requiring only six gears for the various



NEW DESIGN OF LATHE WITH GEARED VARIABLE-SPEED HEADSTOCK DRIVE.—AMERICAN TOOL WORKS COMPANY.

changes of spindle speeds. It has a very few parts and less gears than any other similar device. All the gearing and mechanism are neatly and completely housed in, and the gears are arranged to run at very low pitch line velocities, reducing to a minimum the noise incidental to all-gear drives. Friction clutches are used throughout, thus avoiding the necessity of slip gears, pull pins, hollow shafts, tumbler gears or complicated and frail parts.

This construction, in connection with a fifteen-speed motor, was made to provide sixty spindle speeds on the 20-inch lathe, ranging from 5 to 322 rev. per min., in geometrical progression, all of which are instantly and easily obtainable while the tool is in operation; the motor controller lever is located on the right hand side of the apron convenient to the hand of the operator. This speed-changing mechanism is also adaptable to belt driving from a countershaft, as in the illustration; it also has the advantage that the great flexibility of this construction will permit a machine thus installed as a belt-driven lathe to be readily converted into a motor-driven lathe at any future time.

This new design of lathe is unquestionably a step in the right direction as the general trend of machine tool progress points toward the use of machines with variable-speed driving mechanisms. The advantages offered by the geared variable-speed drive are incomparably greater than the antiquated cone pulley and belt drive. Especially is this gear mechanism of advantage in connection with motor driving; with constant-speed motors a convenient range of speeds is provided, while in applying a variable-speed motor, the speed range in the motor may be greatly reduced, without sacrificing the resultant range at the lathe spindle—this permits a much smaller motor to be used. The American Tool Works Company are to be commended for bringing out this design.

VIBRATION TEST OF STAYBOLT IRON.

Last August the Grand Trunk Railway conducted some vibratory tests on a number of staybolt irons by different makers, with a view of reproducing in severer form the vibrations to which staybolts are subjected in locomotive boilers. The vibrations were produced at a rate of 32 per minute. The results, which are received from the Falls Hollow Staybolt Company, are as follows:

	Size.	Duration.	Broke on
Falls hollow charcoal iron.....	1 in.	157 mins.	5,024 vibrations
Falls solid charcoal iron.....	1 in.	131 mins.	4,192 vibrations
"B" iron	1 in.	75 mins.	2,400 vibrations
"C" iron	1 in.	75 mins.	2,400 vibrations
"D" iron	1 in.	85 mins.	2,635 vibrations
"E" iron	⅞ in.	120 mins.	3,840 vibrations
"F" iron	1 in.	95 mins.	3,040 vibrations

The actual duration of the Falls hollow charcoal iron was 161 mins., equal to 5,192 vibrations, but the resistant strength of the sample caused intermittent attention by the tester, with wooden wedges to keep the sample taut, and for this 4 mins. were deducted.

EQUIPMENT AND MANUFACTURING NOTES.

A centrifugal pump of novel design and unprecedented capabilities will be exhibited at the St. Louis Exposition by Henry R. Worthington, of New York City. That this pump marks a distinct departure from the usual centrifugal practice will be appreciated when it is stated that it will be capable of delivering about 500 gals. of water per minute against a head of 250 lbs. per square inch, and with high efficiency. This pump is of the type known as the multi-stage, turbine centrifugal, and differs in a great many respects from the centrifugal pumps with which engineers have been familiar.

Work is fast nearing completion upon the new power plant of the B. F. Sturtevant Company at Hyde Park, Mass. This bids fair to be one of the most complete plants of its kind in the country, special care having been taken in connection with every detail to secure the highest efficiency and the most modern equipment. The plant will comprise four water tube boilers, with stokers supplied by forced draft, an economizer with induced draft, and a complete outfit of generating sets, all of the Sturtevant make, together with condenser, air compressor, etc. The Sturtevant exhaust head is also used for separating the water and oil from the exhaust steam from the engines.

The Kennicott Water Softener Company have established an office at 29 Great Saint Helens, London, E. C., England.

Mr. Irving H. Reynolds will soon retire from the Allis-Chalmers Company and the duties of chief engineer will be assumed by the engineers in charge of the various departments, these engineers availing themselves of the advice of Mr. Edwin Reynolds, consulting engineer of the company.

Messrs. Pedrick & Ayer, Plainfield, N. J., announce the appointment of Mr. R. O. Cumback as superintendent of their plant at that point. He has for several years been connected with the motive power department of the Central Railroad of New Jersey at the Elizabethport shops.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, have recently doubled the capacity of their works for the manufacture of their double refined, charcoal iron, hollow and solid staybolt material. They have also added a 50 by 200 ft. extension to their buildings for increase of storage capacity for raw material and manufactured product.

The Washburn Company, of Minneapolis, Minn., announce that they have made arrangements with the Pennsylvania Malleable Company, of Pittsburgh, Pa., to manufacture and sell all their different types of couplers in the Central, Eastern and New England States. The Washburn Company will continue the sale and manufacture in other parts of the country.

Riehle Bros. Testing Machine Company, 1424 North Ninth street, Philadelphia, Pa., announce that because their catalogues have become too bulky for general distribution (the nine catalogues weigh three pounds) they are sending out coupons upon which any desired catalogue may be ordered, whereupon it will be promptly sent by mail. These pamphlets are described in folders which are issued with the coupons.

Wm. B. Scaife & Sons Company, of Pittsburgh, Pa., manufacturers of the Scaife and We-Fu-Go Systems for softening and purifying water, have appointed Mr. C. A. Malau, of the City of Mexico, their sole representative in that Republic for the sale of their various systems for this purpose. This company is now manufacturing several types of water purifying systems; intermittent or continuous; treating the water either hot or cold. They have had an extensive experience in this line, and are prepared to carry out any kind of water purification which they undertake. They report that they are now softening and purifying 350,000,000 gals. of water daily for steam boilers and other industries where pure soft water is desirable with their various systems. Mr. Malau is especially well fitted to look after his clients in Mexico, as he is thoroughly acquainted with the engineering and industrial wants of that country, and has devoted considerable attention to the subject of water purification.

From a San Francisco correspondent we learn that at the Nimshew Power House of the Valley Counties Power Company, a sub-company of the California Gas & Electric Corporation, the first two machines have begun operation, feeding into the transmission line of the Bay Counties Power Company. The power house is located in the Butte Creek Canyon, twenty-four miles from Chico. The available total head of water is 1531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections, from 30 to 28½ inches diameter. Within the power house the pipe terminates in a Y, each branch of the Y supplying a 3,700 h.p. water-wheel, the largest wheels operated as yet by one single jet of water. The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel; the entire hydro-electric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung. The shaft and disc are nickel steel forgings, (the shaft being hollow forged and oil tempered,) made by the Bethlehem Steel Company; and the buckets are steel castings of the patented ellipsoidal type. The total weight of the revolving part of each unit is over forty tons; the speed, 240 rev. per. min. Each water-wheel is provided with a Doble patented needle, regulating deflecting nozzle and hydraulically operated piston gate, a Lombard type D governor with electric speed controller, taking care of the sudden fluctuations of the load by deflecting the nozzle, whereas the regulating needle is operated by hand and set according to the average load of the respective hours of the day. The hydraulic machinery, including shaft, bearings and gates, was designed and built by the Abner Doble Company of San Francisco.